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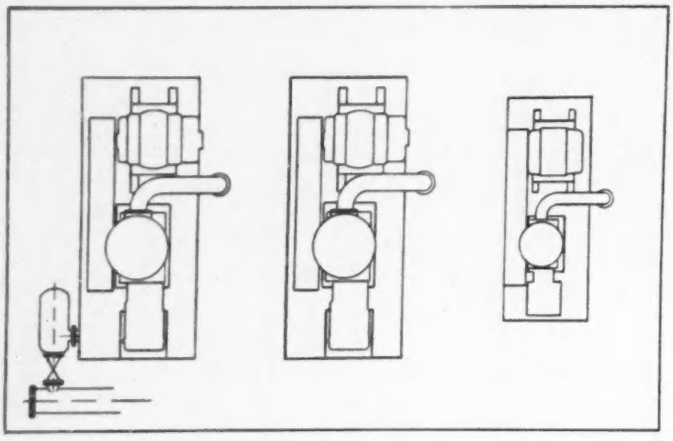
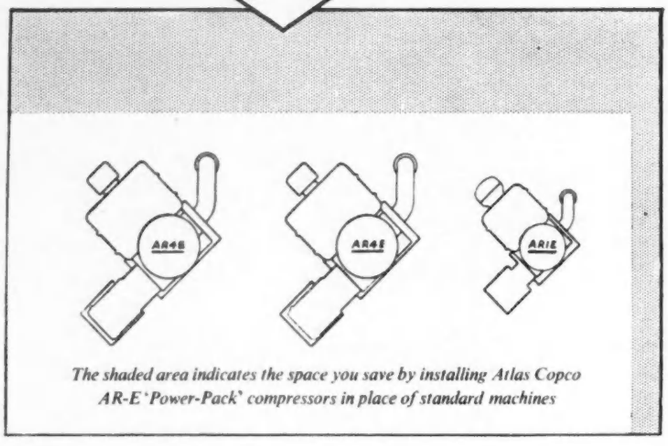
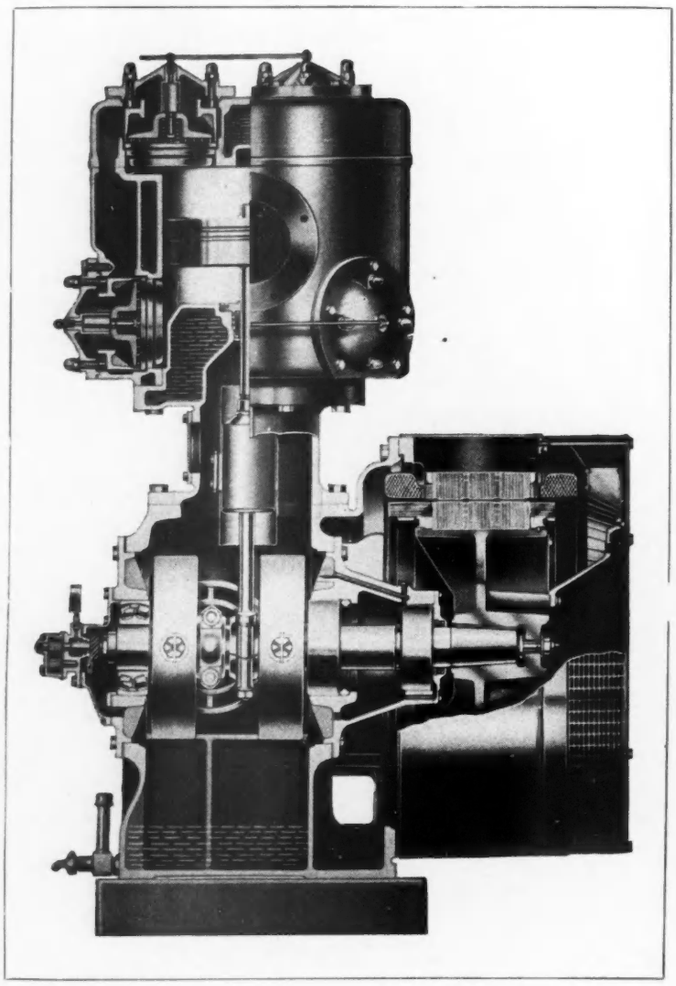




The shaded area indicates the space you save by installing Atlas Copco AR-E 'Power-Pack' compressors in place of standard machines

with Atlas Copco 'Power-Pack' Compressors



The Atlas Copco AR-E 'Power-Pack' range is a series of heavy-duty stationary compressors, specifically designed to cut down on floor space and installation costs. The diagrams above show how these compact machines save on space—up to 25% in this typical installation.

Installation costs are cut because AR-E compressors are delivered complete. The motor is an integral part of the unit, mounted on the compressor casing. Putting an AR-E to work takes virtually no time at all—particularly when mounted on skidframes, when bolting-down is unnecessary and the machines can easily and quickly be moved.

Maintenance is reduced because there is no vee-belt or coupling, and the motor is bolted directly to the crankcase, eliminating risk of misalignment.

World-wide sales and service

AR-E 'Power-Pack' compressors are just a few of the great range of compressed air machines manufactured by the Atlas Copco Group, and sold and serviced throughout the world. For further details, contact your local Atlas Copco Company or Agent, or write to Atlas Copco (Great Britain) Limited, Beresford Avenue, Wembley, Middlesex, or Atlas Copco AB, Stockholm 1, Sweden.

Atlas Copco *Manufacturers of Stationary and Portable Compressors, Rock-Drilling Equipment, Loaders, Pneumatic Tools and Paint-Spraying Equipment.*

C18

THE ENGINEER

Established 1856

No. 5327 **FEBRUARY 28, 1958** VOL. 205

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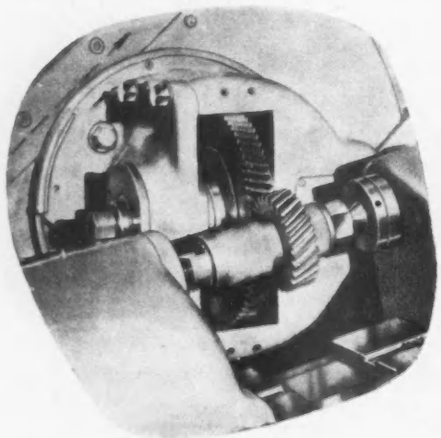

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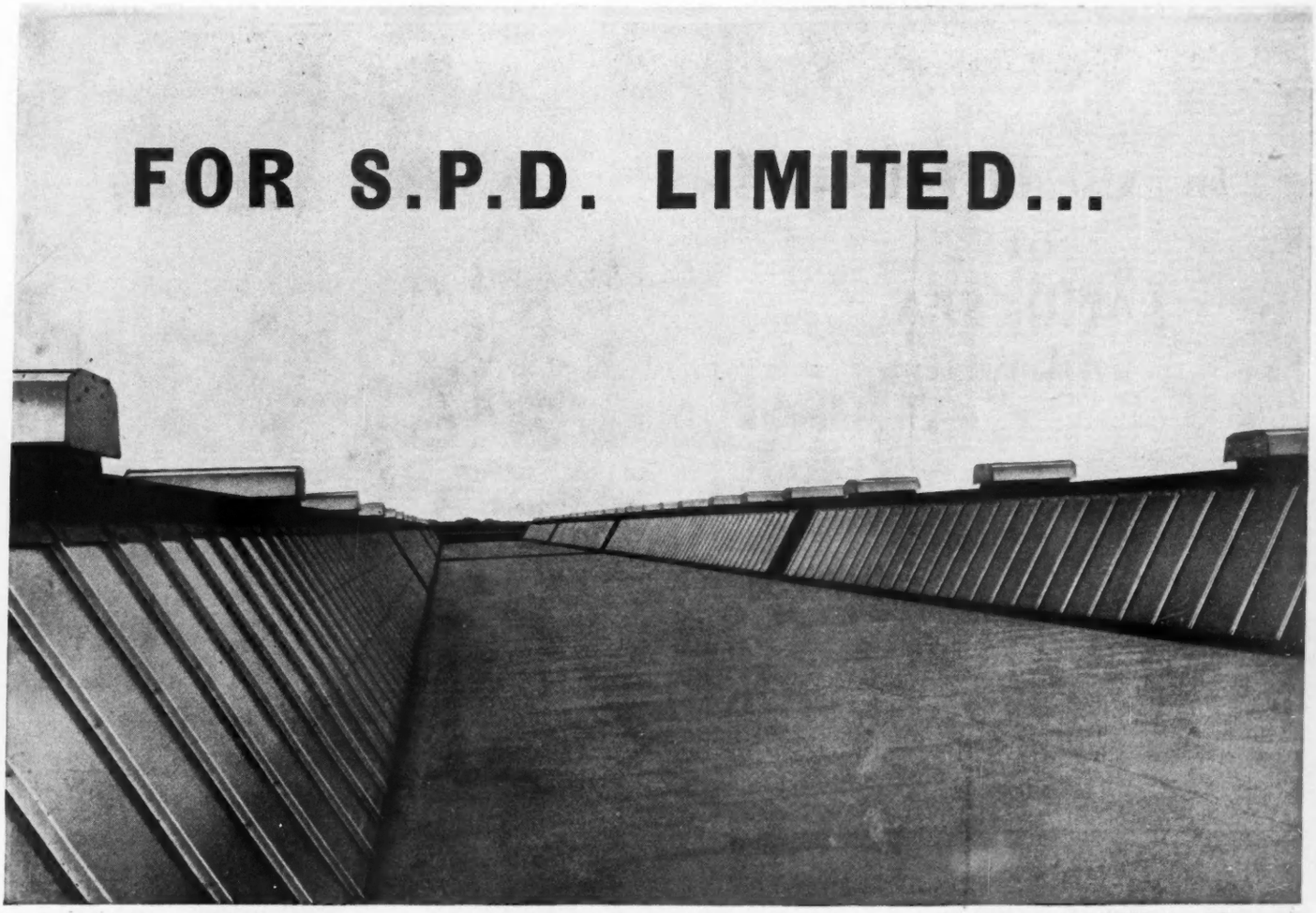

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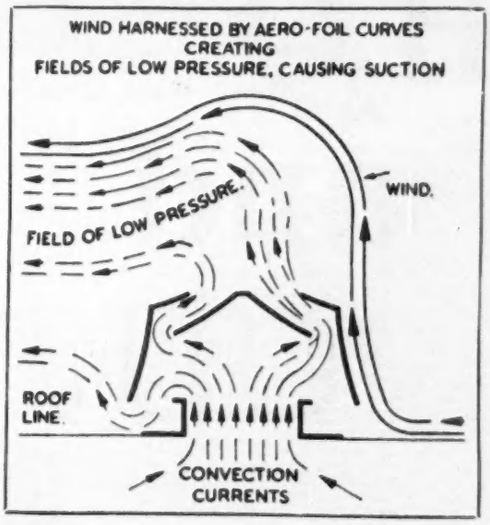

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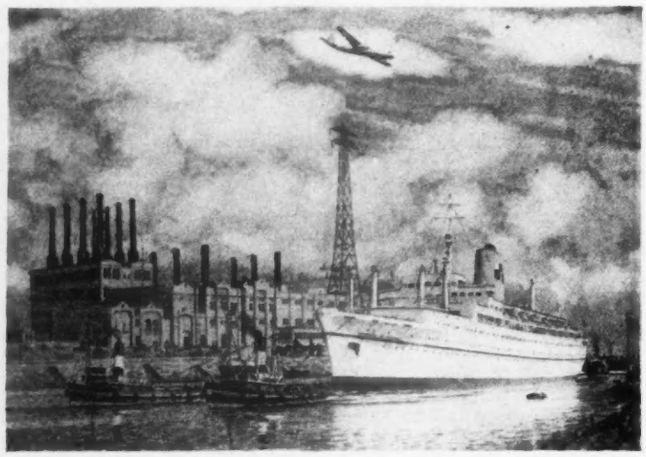

This Clyde scene was commissioned to demonstrate how diverse are the present day applications of Cockburns Valves and Associated Controls. Resisting the temptation to include, for instance, a chemical works and an oil refinery has, we hope, contributed to the effect.

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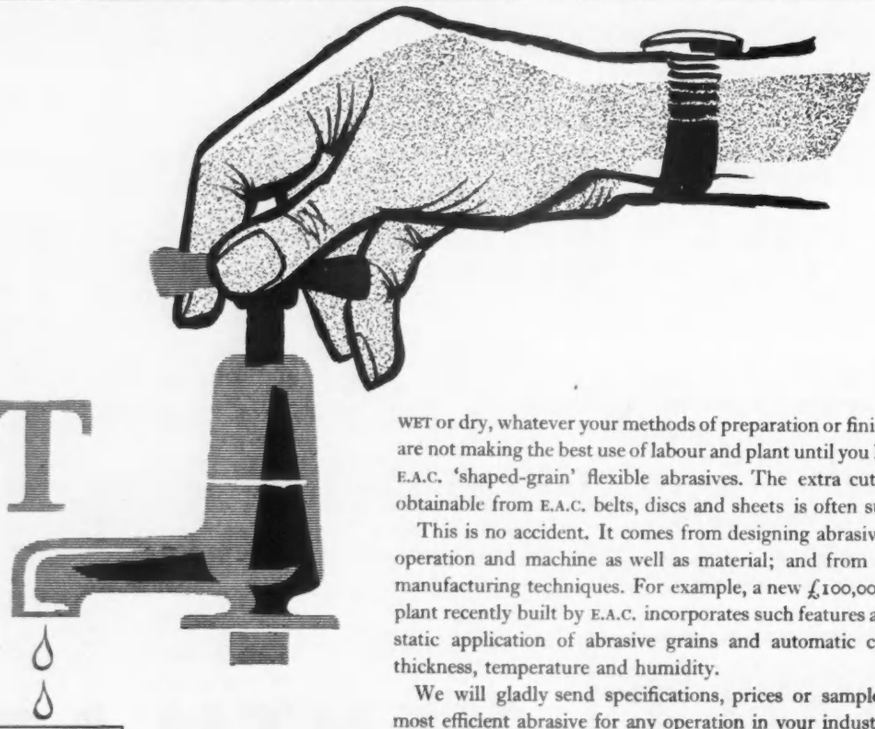

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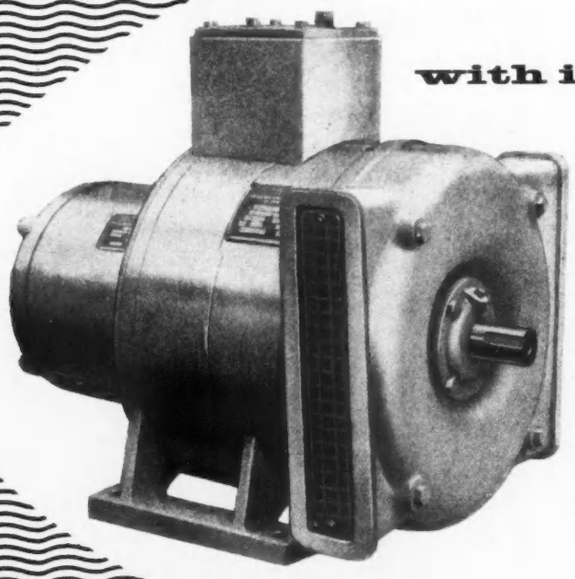

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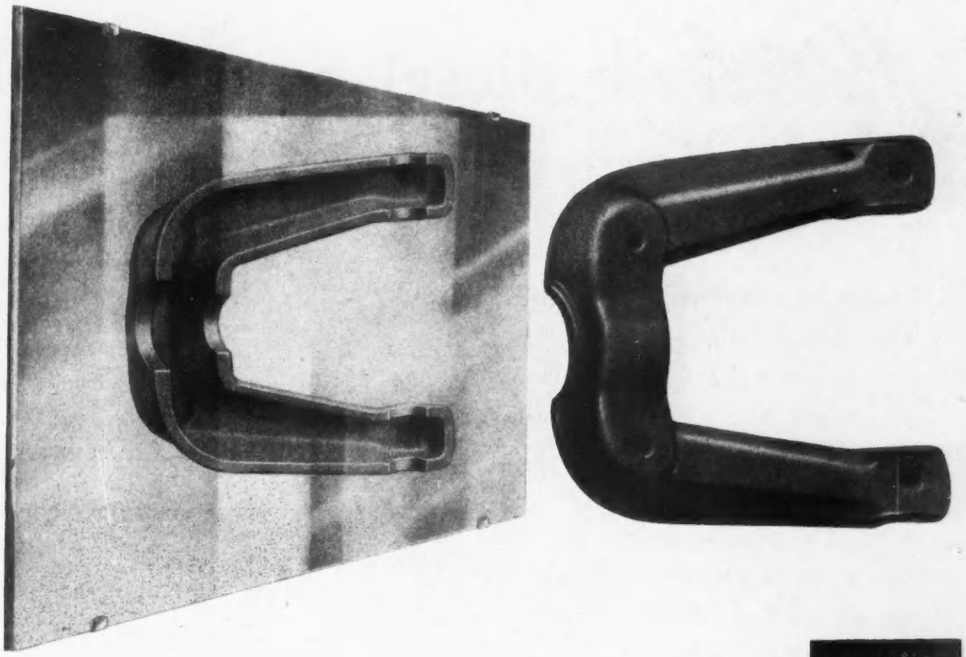

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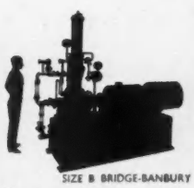

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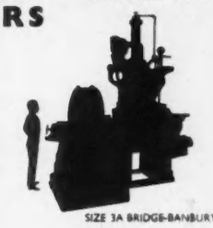

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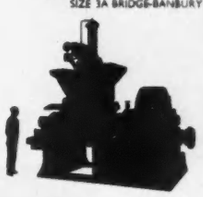

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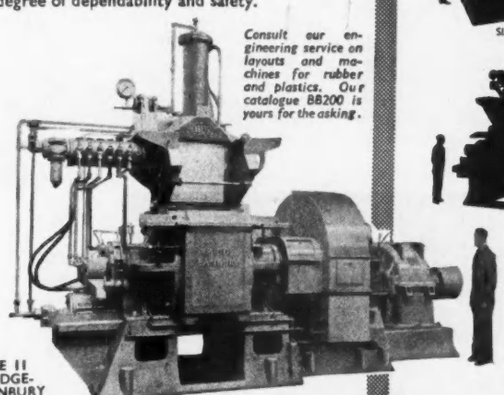

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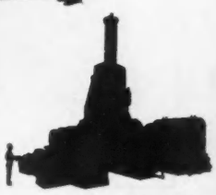

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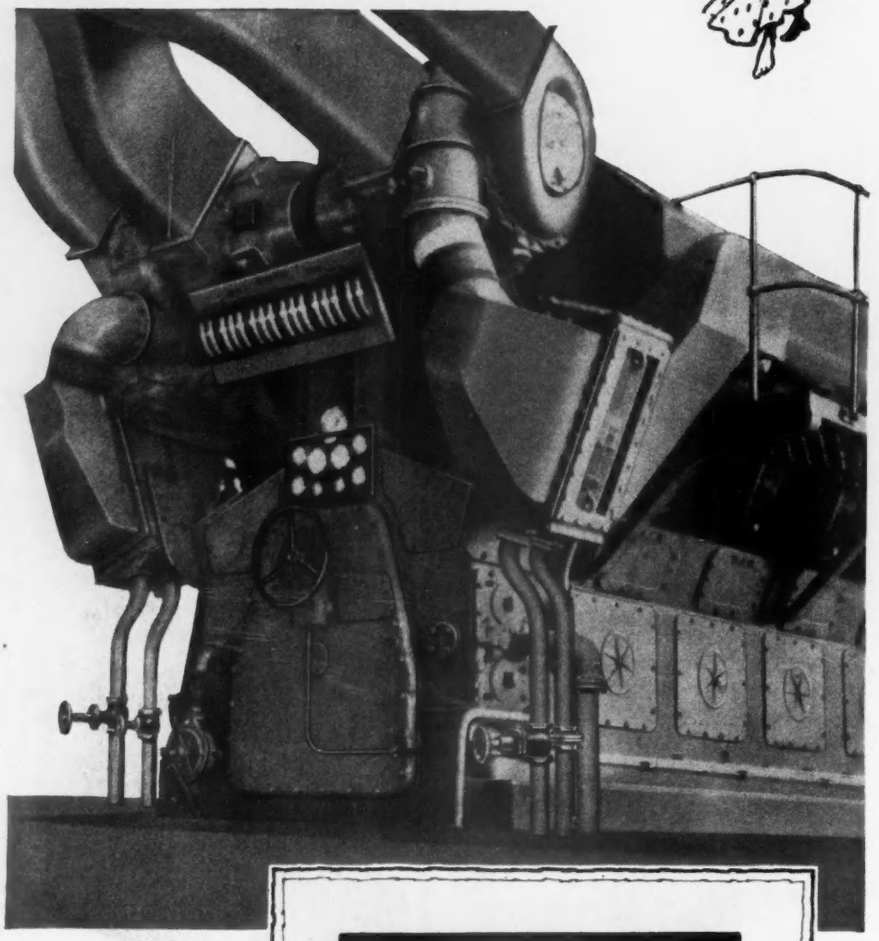

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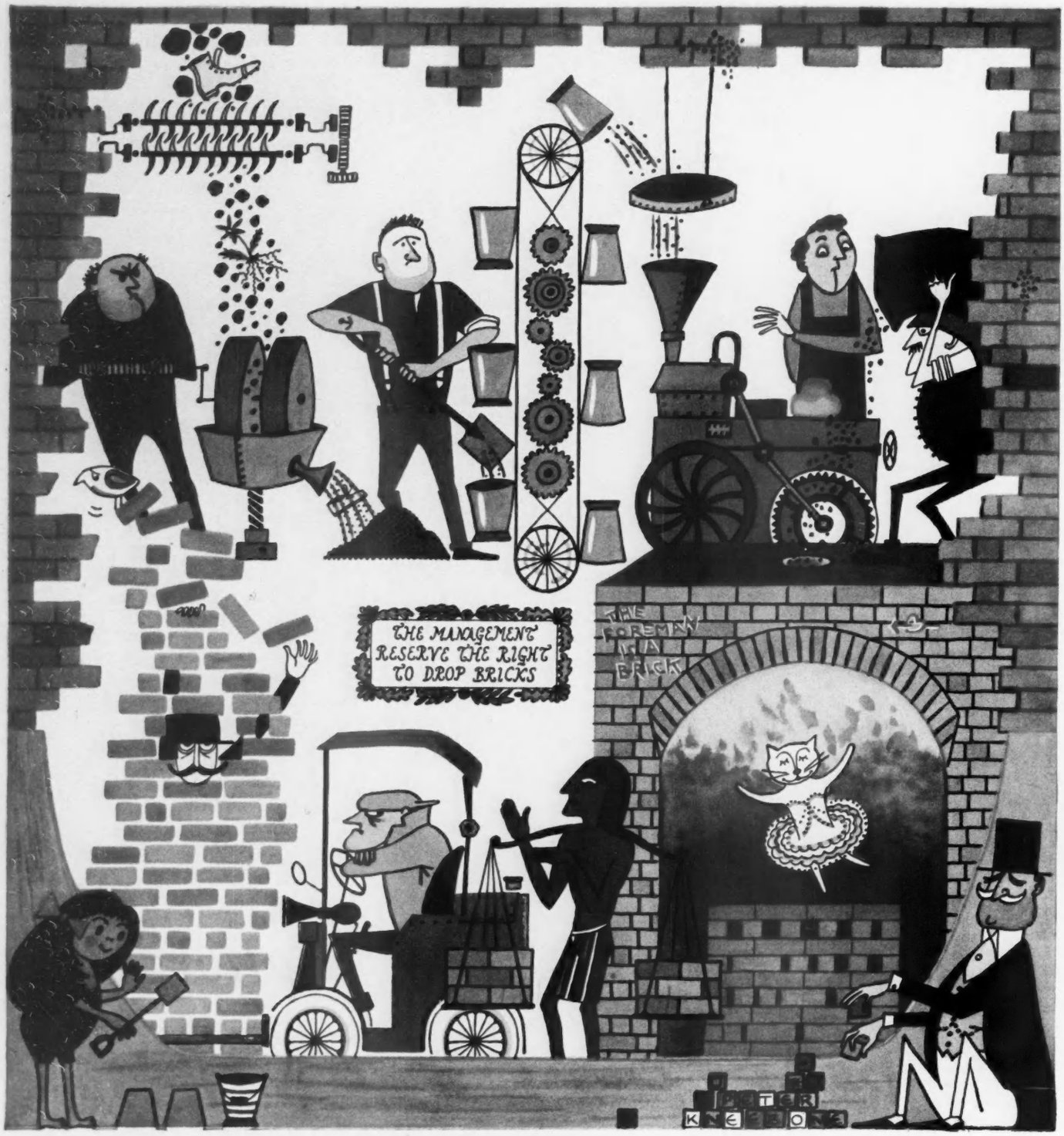

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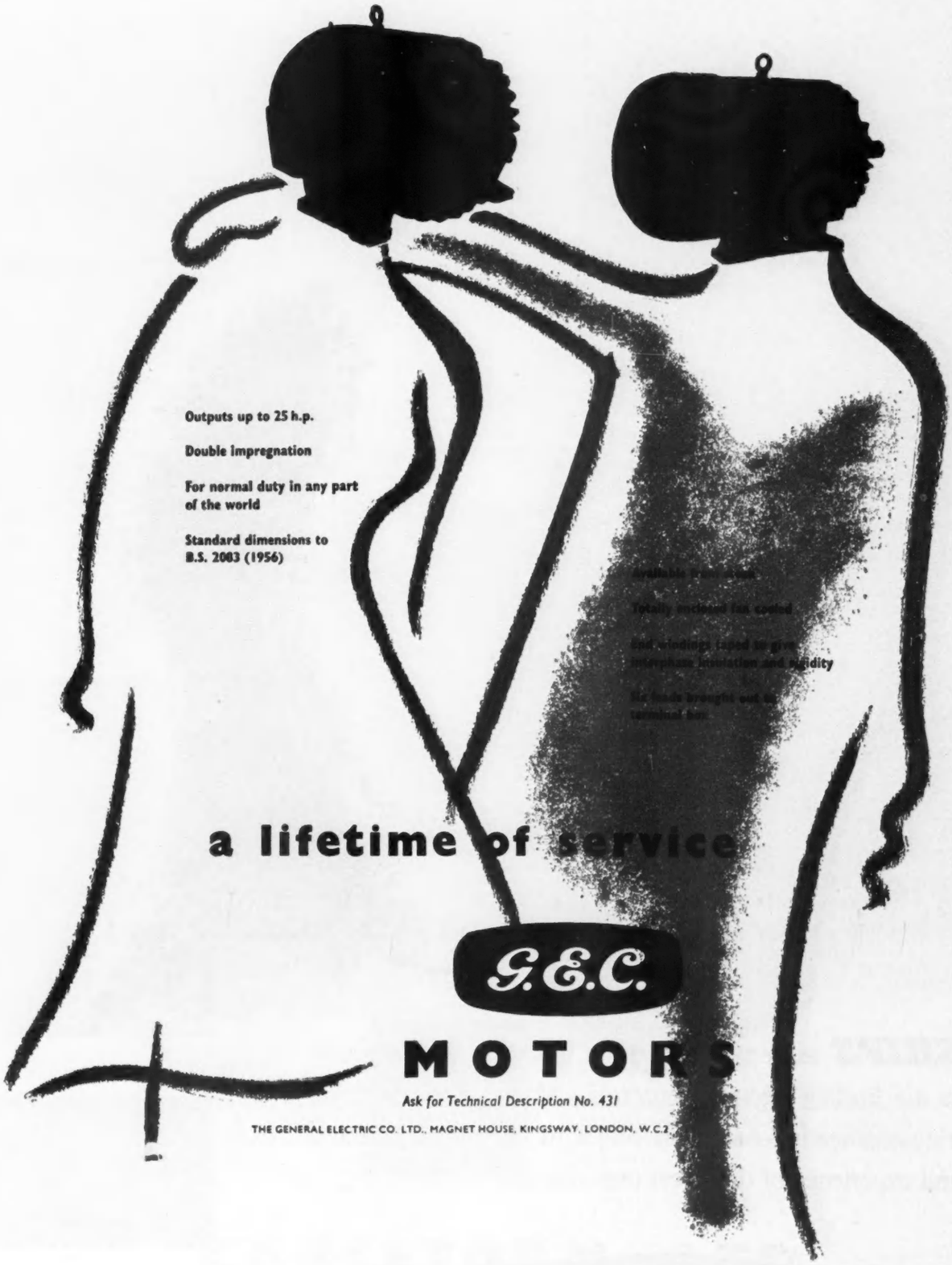
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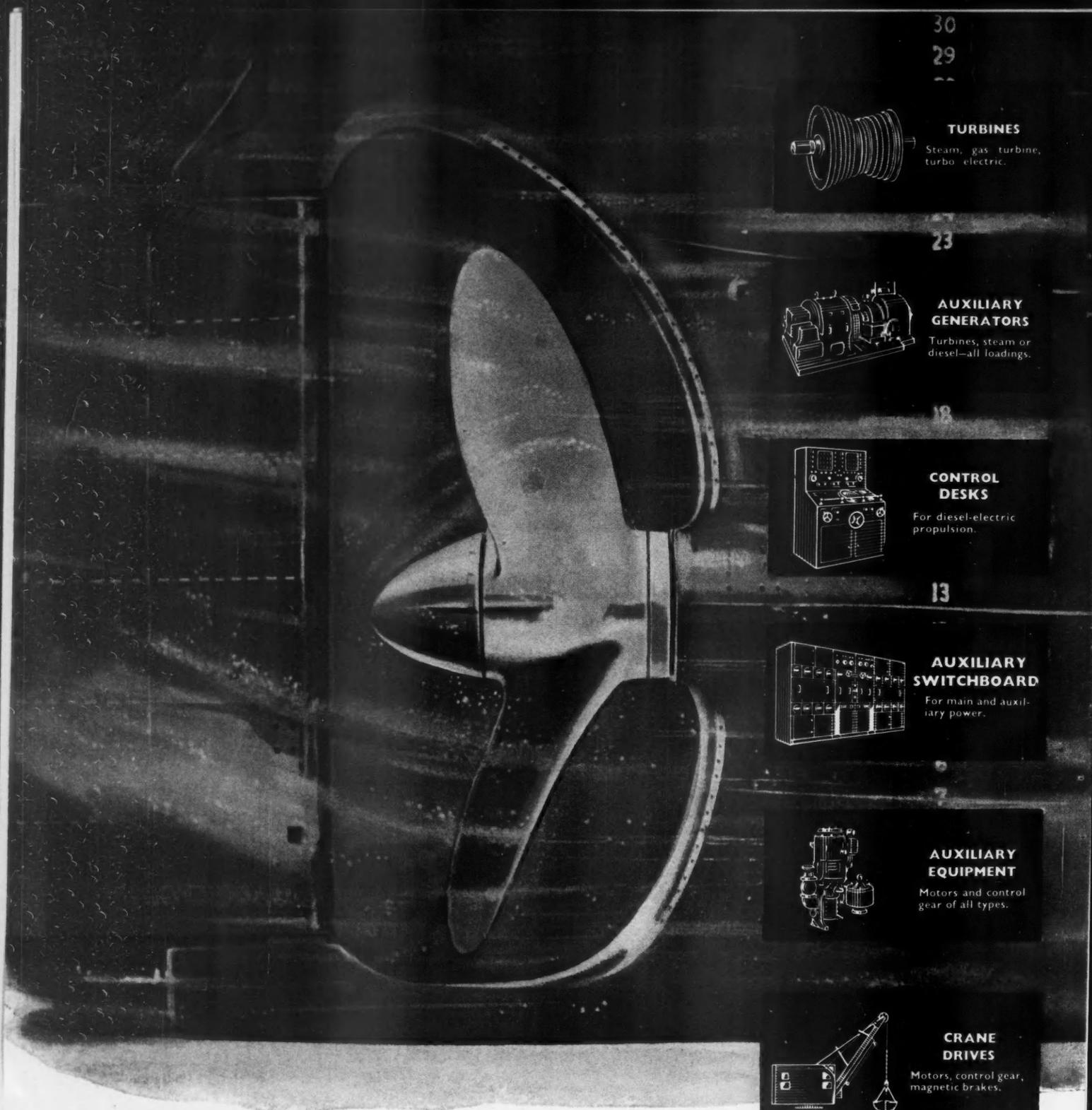

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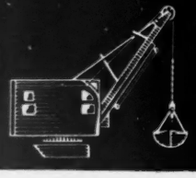

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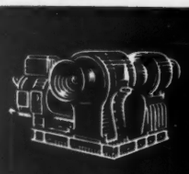

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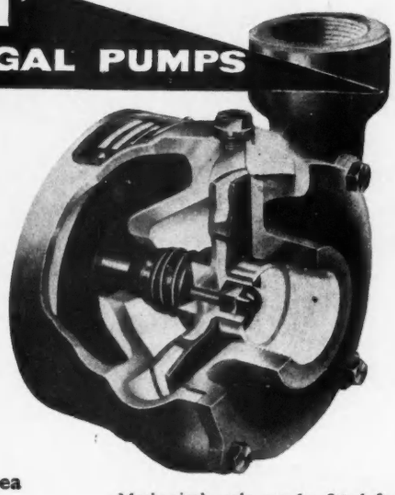


These Girdlestone pumps have been designed to ensure efficient mechanical shaft sealing. The simple and effective arrangement of the seal has these advantages.

- **Complete cooling of seal by liquid pumped without flushing pipes.**
- **Large internal liquid area prevents suspended or foreign matter settling around seal.**
- **Simple seal replacement by removal of suction end cover and impeller only.**

Mechanical seals can be fitted for handling a wide range of solvents, acids and other difficult liquids. Pumps available in five sizes from ¾ in. to 1½ in.—cast iron, bronze or stainless steel. All sizes have same shaft and flange dimensions for interchangeability of mounting —direct couples, belt-driven or as motorpump unit.

Write for fully informative leaflets to:

GIRDLESTONE PUMPS LIMITED

23 Davies Street, London, W.1. MAYfair 1354/5 & 5317

T.115

Making technical advertising effective

Even modest advertising campaigns can be effective if placed in the hands of advertising agents who can put your case in the right way.

In industrial publicity, in which we specialise, we at Rowlinson-Broughton are able to provide that right approach. We produce lively ideas, write sound technical copy, with artwork of first quality and have a very keen appreciation of our clients' manufacturing and marketing problems. We believe, and our clients confirm, that we can and do make industrial and technical advertising effective.

R·B

ROWLINSON - BROUGHTON

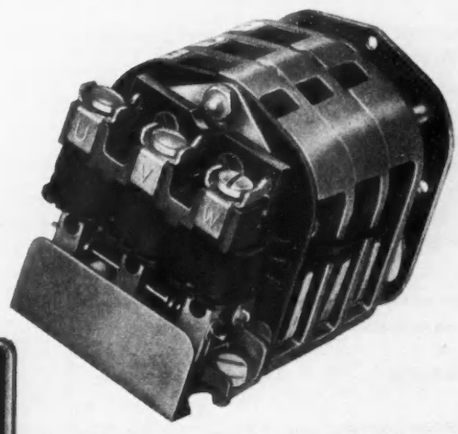
Incorporated Practitioners in Advertising

ROYAL BUILDINGS · 2 MOSLEY STREET · MANCHESTER 2 · Tel: CENtral 7816 (3 lines)

R16

UNIQUE DEPARTURE IN MOTOR PROTECTION

Occupies less than 3" cube. Available for flush, panel and metalclad surface mounting. Specially suitable for machine tools, domestic appliances etc. Economical in space and price.



Motor protection switch with built-in thermal and magnetic overloads. Single or multi-pole. Ratings from 0·7 amp to 10 amps. Up to 500 volts.

Further details from :-

CABLEFORM LTD.

ROMILEY CHESHIRE *Woodley 2246*

Sole concessionaires in U.K. of WEBER (Swiss)

D

A question that is sure to be asked–

IS IT MAJOR EQUIPPED?

It's one of the first questions buyers of industrial equipment ask. For they know the Major Industrial Equipment Unit possesses all the qualities they seek — unrivalled reliability, the ability to increase output economically, and the ability to maintain that output in the most difficult conditions. They know the enormous benefits of standardisation, and of being able to use the world-famous service and spare parts supply for their industrial equipment as well as for their Thames Trucks and Fordson Industrial Tractors. There are big benefits, too, for the manufacturer who fits these Ford-built units. For full details ring Rainham 3000 today.

Major Industrial Equipment Units are available in 4 basic combinations :—

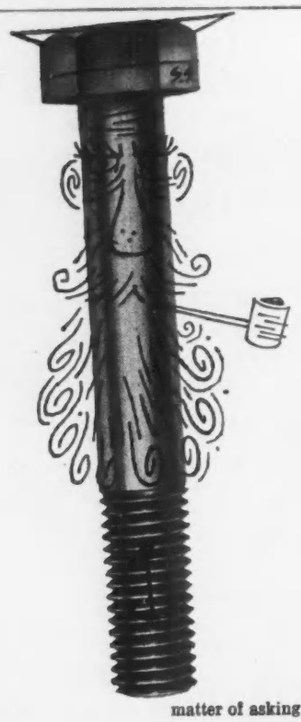
1 *Engine + transmission*
2 *Engine + transmission + hydraulics*
3 *Engine + transmission + hydraulics + steering*
4 *Engine + transmission + hydraulics + steering + front axle.*

Other combinations can include Rear Power Take Off, 2-speed Belt Pulley, alternative clutch and gear housings, etc. In all, over 100 standard combinations.

ENGINE DETAILS	Diesel	Petrol
CUBIC CAPACITY	3.61 litres	3.26 litres
COMPRESSION RATIO	16 : 1	5.5 : 1
BRAKE HORSE POWER		
AT: 1200 RPM	34.0	34.0
1400 RPM	40.0	38.0
1600 RPM	44.0	42.0

All enquiries to :—
INDUSTRIAL SALES DEPARTMENT TRACTOR DIVISION
FORD MOTOR COMPANY LTD DAGENHAM ESSEX Tel: Rainham 3000

WISE BUYERS INSIST ON MAJOR POWER



this A.B.* is a tough old salt

* **ALUMINIUM BRONZE** has all the traditional Naval qualities. That's why Lanarkshire make so many A.B. bolts, for they stand up to really hard wear and offer a high resistance to sea-water corrosion — just like any good sailor. On or by the sea, and even far inland, on chemical plants, oil refineries and electrical installation work there are many uses for a material of 45-55 tons tensile strength, which is not troubled by temperatures of 300-400° C, and is immune from dezincification. For the technical it is Aluminium Bronze D.T.D.197A and B.S.2033. For those who like to keep things simple it is a matter of asking Lanarkshire for A.B. Bolt. Aye, Aye, Sir!

Black, bright, non-ferrous bolts and nuts, and high tensile bolts, too, by

LANARKSHIRE BOLT LIMITED

Hamilton · Lanarkshire · Scotland · Tel : Hamilton 1241-4

DO YOU KNOW YOUR PRESENT STEAM RAISING COSTS?

May we investigate without charge?

"TURBINE" FURNACES

burning small slack coal efficiently and smokelessly will show a definite saving in steam raising costs

TURBINE FURNACE COMPANY LIMITED

238b, Gray's Inn Road, London, W.C.1. 'Phone : TERminus 4365

Bandalasta BINOCULAR MAGNIFIER

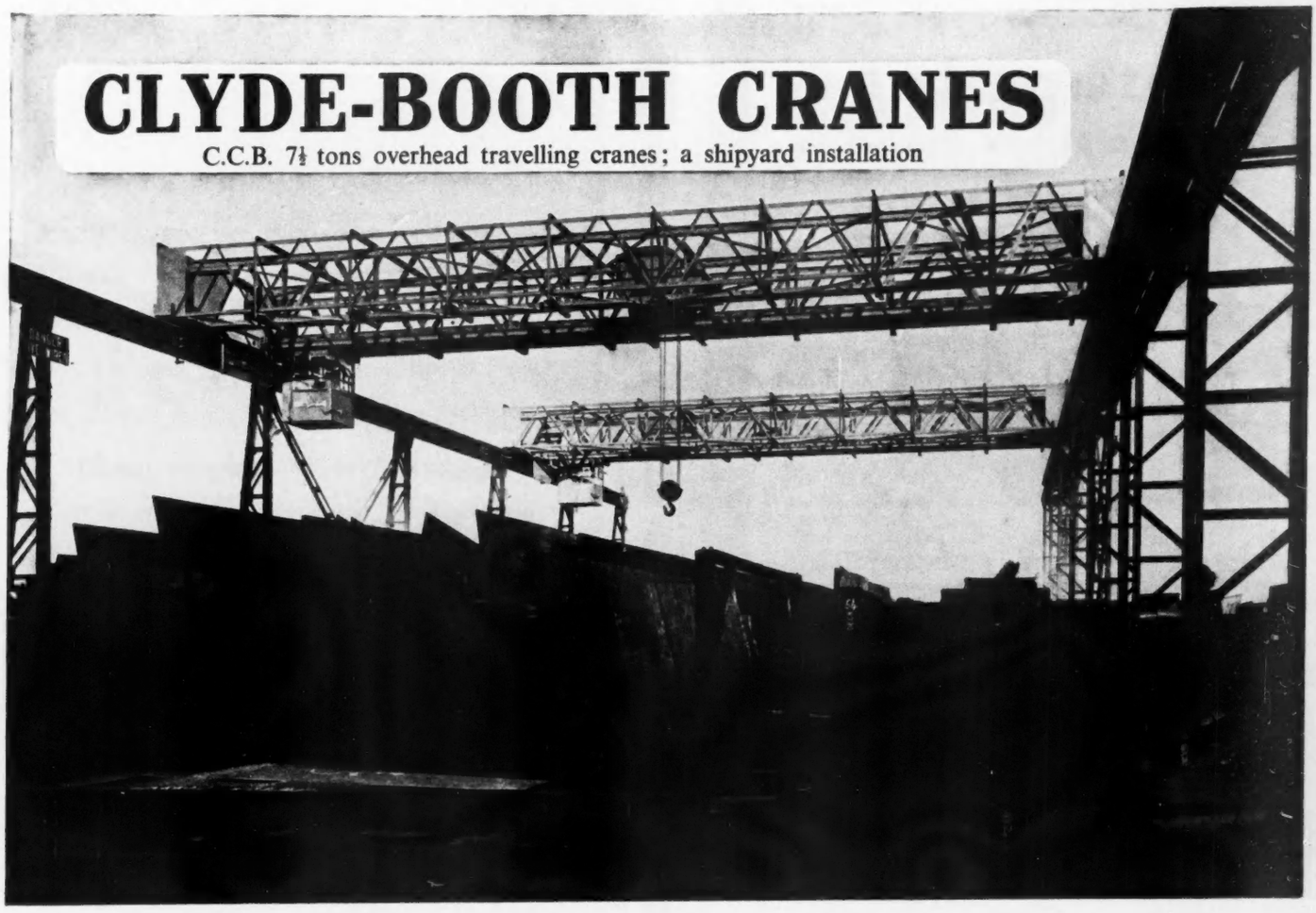
For inspection and other fine work

CAN BE WORN OVER SPECTACLES

BROOKES & ADAMS *Limited*
BARR STREET · HOCKLEY · BIRMINGHAM 19
PHONE : NORTHERN 2903-4 · GRAMS : TELEBA, BIRMINGHAM

CLYDE-BOOTH CRANES

C.C.B. 7½ tons overhead travelling cranes; a shipyard installation



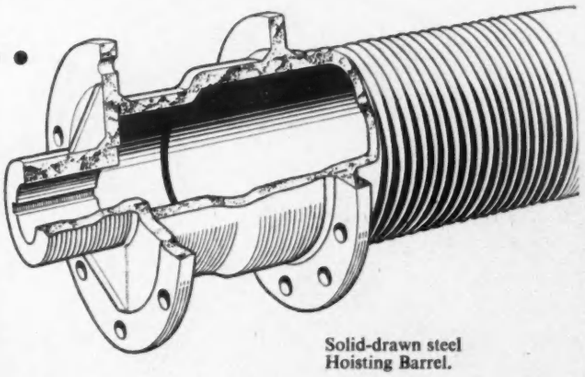
Salient Features of Clyde-Booth Design.....

HOISTING BARRELS...

Barrels up to 36 inches diameter are made from seamless hollow steel forgings with one end left solid and the other end necked down to enter gear box.

C.C.B. forged steel barrels have these advantages:

- **Greater strength and less weight throughout.**
- **Guaranteed concentricity—barrel in balance.**
- **Driving gear bolted direct to flange on barrel avoids transmitting drive through keyways.**
- **Deep flanges safeguard rope against leaving barrel.**
- **Virtually unbreakable.**



Solid-drawn steel Hoisting Barrel.

CLYDE BOOTH

CLYDE CRANE & BOOTH LTD
incorporating

Clyde Crane & Engineering Co.,
MOSSEND, Lanarkshire.
Telephone: Holytown 412 (6 lines). Telegrams: "Clyde," Motherwell.

Joseph Booth & Bros.,
Union Crane Works. RODLEY. Leeds.
Telephone: Pudsey 3168 6 lines). Telegrams: "Cranes," Rodley.

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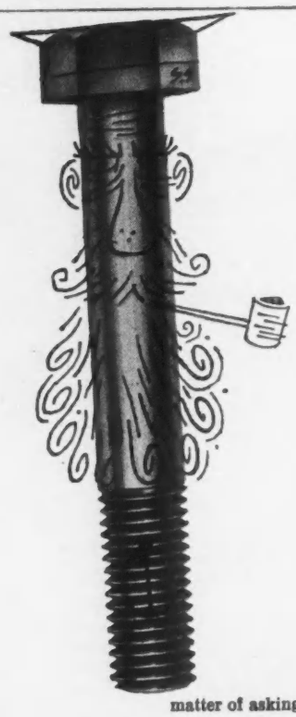

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Black, bright, non-ferrous bolts and nuts, and high tensile bolts, too, by

LANARKSHIRE BOLT LIMITED

Hamilton · Lanarkshire · Scotland · Tel : Hamilton 1241-4

DO YOU KNOW YOUR PRESENT STEAM RAISING COSTS?

May we investigate without charge?

"TURBINE" FURNACES

burning small slack coal efficiently and smokelessly will show a definite saving in steam raising costs

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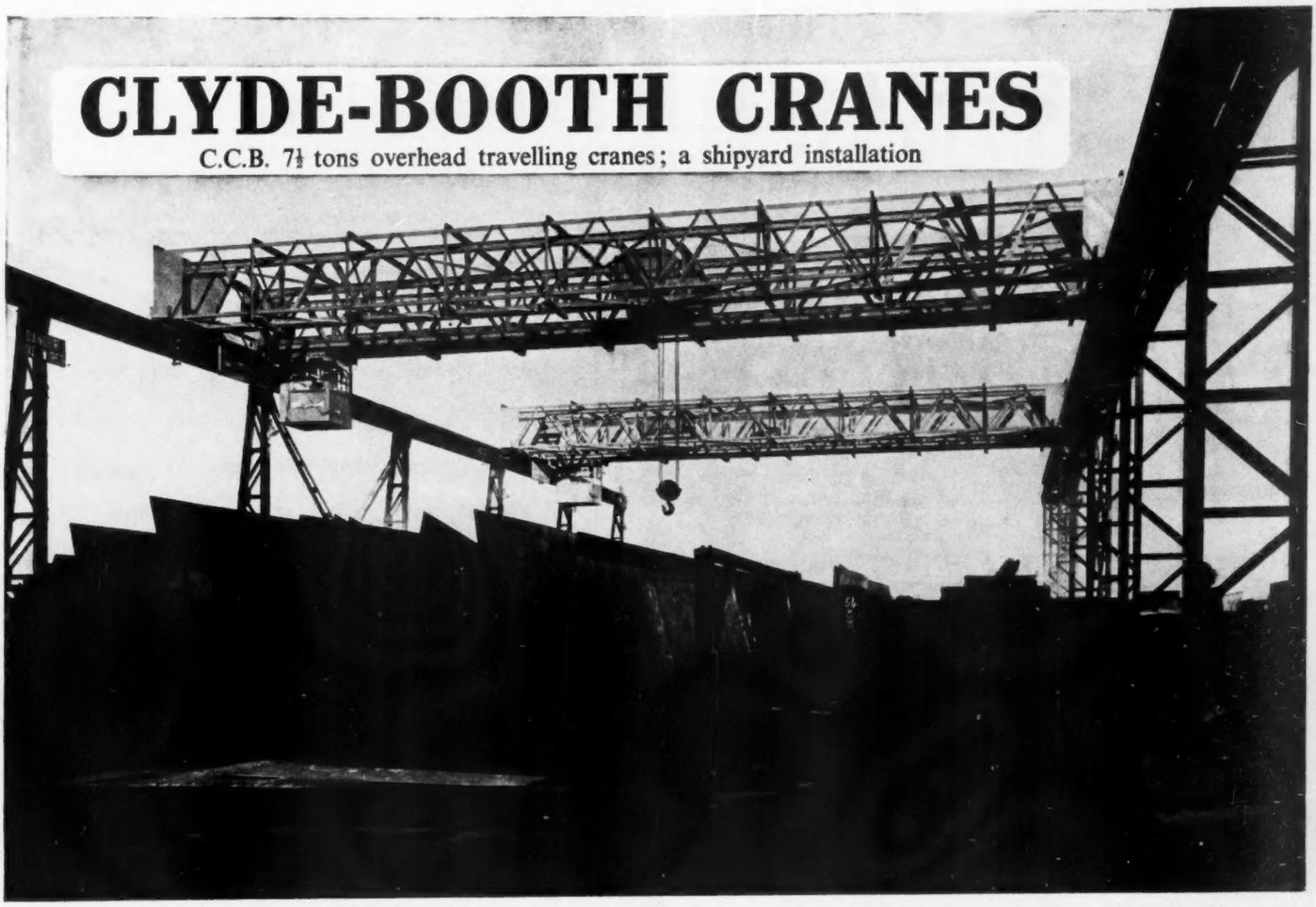

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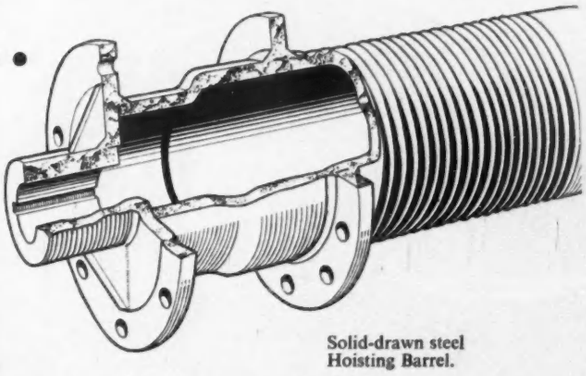

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Telephone: Pudsey 3168 6 lines). Telegrams: "Cranes," Rodley.

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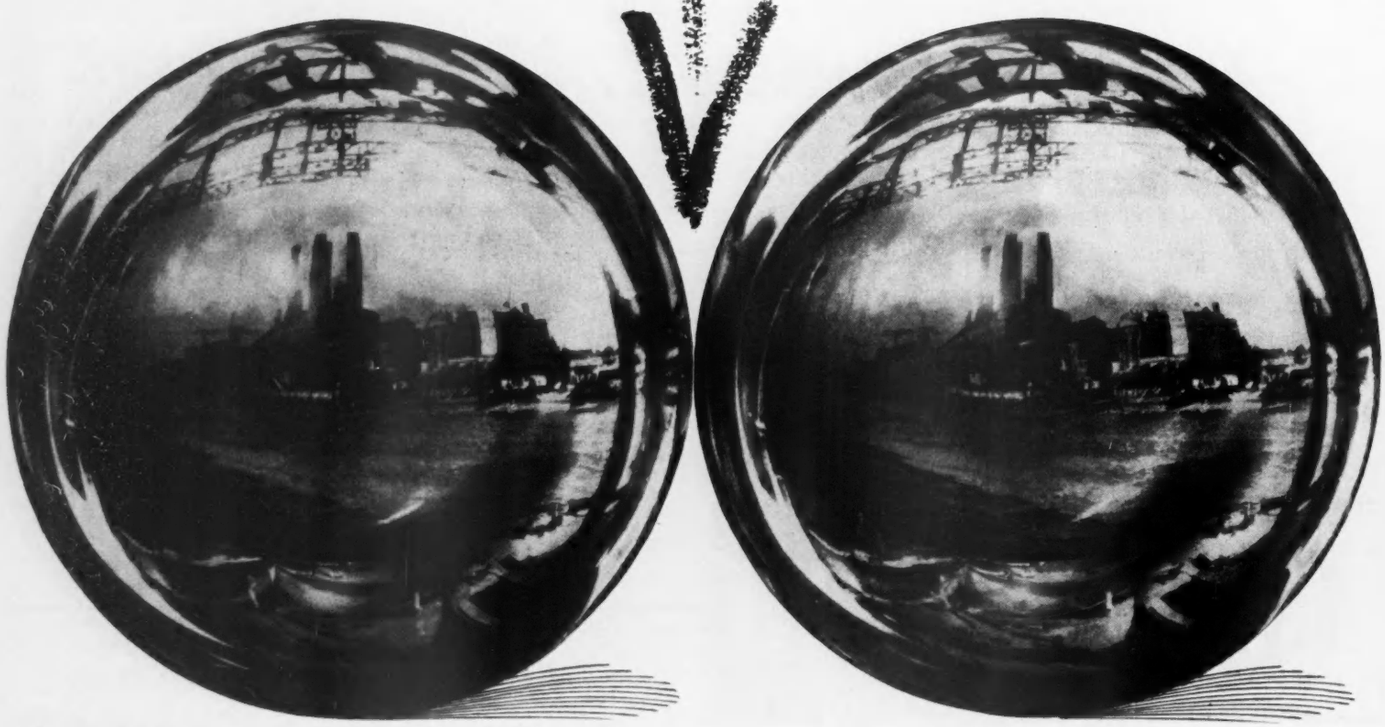
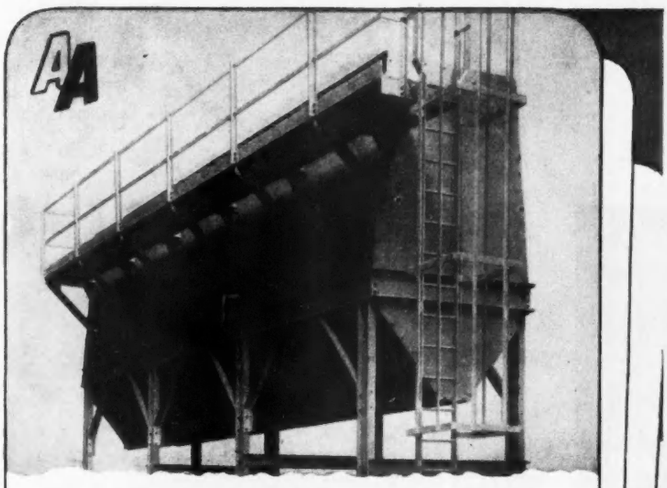
Mobilux Grease is a lithium-base lubricant of excellent structural stability and purity. It is a new, general-purpose grease superseding conventional greases. It provides effective lubrication for the majority of grease applications over a temperature range from minus 20°F to 250°F. It is exceptionally resistant to water washing and contains special additives to prevent rust formation. Both in the laboratory and in the field Mobilux Grease has proved its outstanding efficiency as a lubricant and protector.

MOBILUX GREASE



Mobil MOBIL INDUSTRIAL LUBRICANTS



They take the honours!

Built by specialists, Alfred Allen Hoppers and Chutes, Vessels and Tanks cover a wide range of industrial needs. Because they are well made in every respect, embodying first-class workmanship and attention to detail, every job can be relied upon to give long and satisfactory service.

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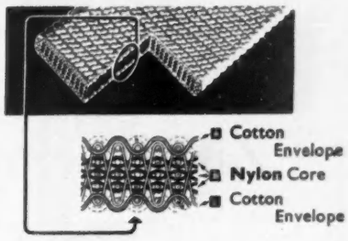
IT'S STRONGER – LASTS LONGER – TRANSMITS MORE POWER – DOES NOT STRETCH

The latest and greatest of a long and famous line is

GRIPOLY *Nylon* BELTING

THE AMAZING PROPERTIES OF NYLON
ITS HIGH-TENSILE STRENGTH
ITS RESISTANCE TO FATIGUE
ITS ELASTICITY

are incorporated by a special weaving technique which involves pre-stressing the nylon core and locking in by means of a thin cotton envelope of high frictional properties.



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LEWIS & TYLOR LTD, GRIPOLY MILLS, CARDIFF

Branches in LONDON · MANCHESTER · GLASGOW and Agencies all over the world

Power Transmission Engineers

Makers of the world famous Patent GRIPOLY Hair Belting
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CENTRIFUGAL —
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THE BEST KNOWN NAME IN *Pumps*

With almost a Century of pumping experience to their credit, Tangyes Limited are able to offer a ready answer to most pumping problems.

TANGYES LIMITED, PUMPS DIVISION, SMETHWICK, BIRMINGHAM, ENGLAND.

BRANCH HOUSES AT LONDON · MANCHESTER · GLASGOW

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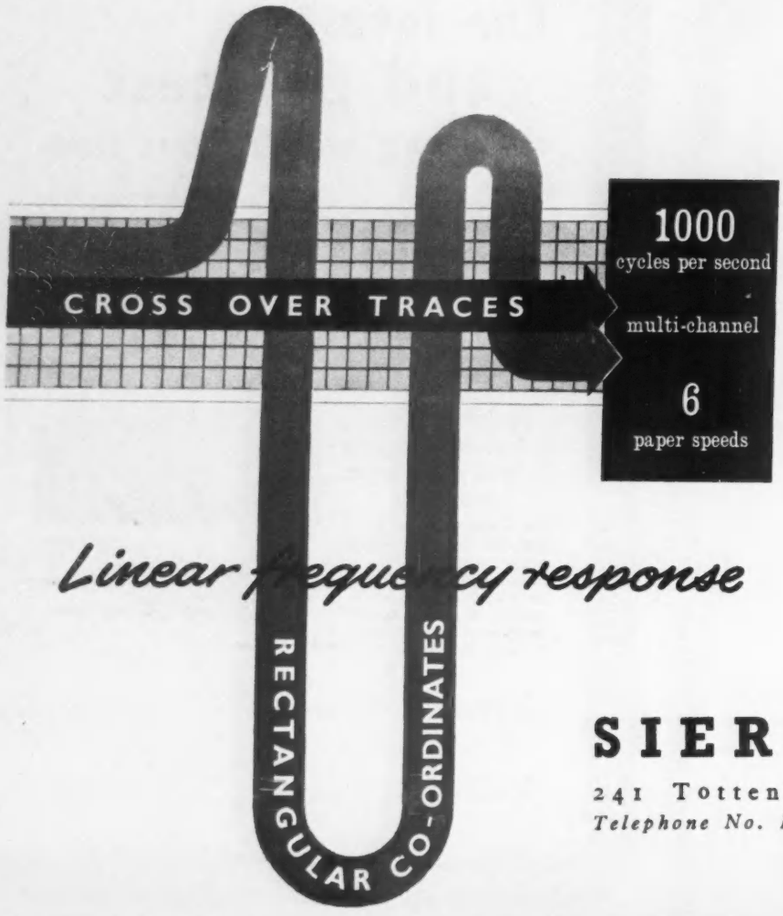

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MINGOGRAPH 230B

A revolution in Oscillographs

The Mingograph 230B permits direct recordings to be obtained of approximately ten times greater frequency range than has previously been possible. It is an outstanding advance in the field of scientific and industrial measuring instruments.

SIEREX LIMITED

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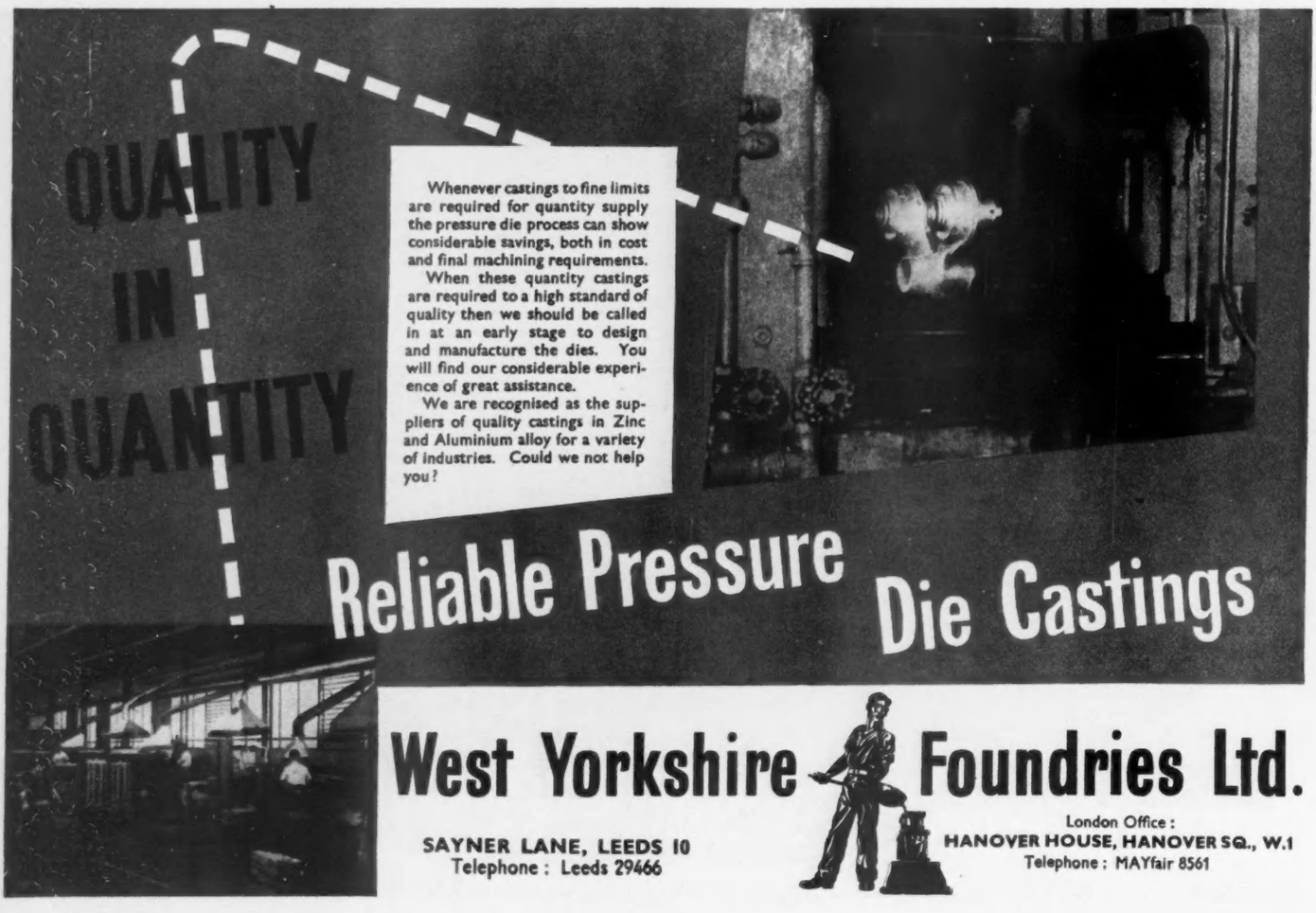
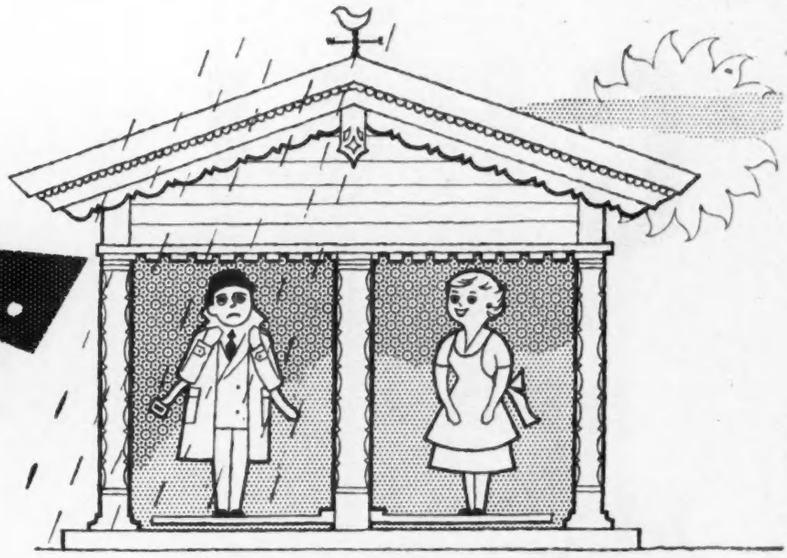

QUALITY IN QUANTITY
Whenever castings to fine limits are required for quantity supply the pressure die process can show considerable savings, both in cost and final machining requirements.
When these quantity castings are required to a high standard of quality then we should be called in at an early stage to design and manufacture the dies. You will find our considerable experience of great assistance.
We are recognised as the suppliers of quality castings in Zinc and Aluminium alloy for a variety of industries. Could we not help you?
Reliable Pressure Die Castings
West Yorkshire Foundries Ltd.
SAYNER LANE, LEEDS 10
Telephone : Leeds 29466
London Office :
HANOVER HOUSE, HANOVER SQ., W.1
Telephone : MAYfair 8561

Wet or fine...

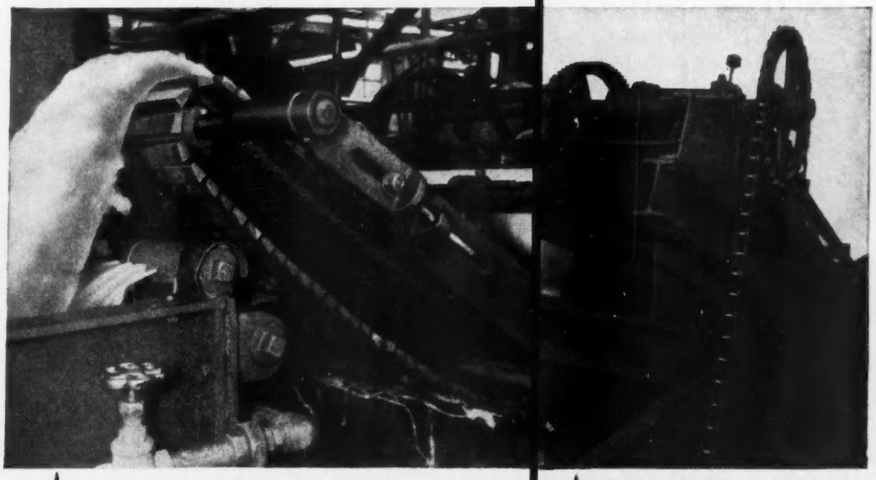
hot or cold



FIT THE COVENTRY MARK 5

steel roller chains as a replacement for malleable chains on slow speed drives and light conveyors on all kinds of machinery and plant where operating conditions are bad and the chains are not enclosed.

Write for Catalogue Ref. 116/101 for full details, dimensions and prices.



In continuous contact with wool saturated in cleaning fluid, containing waste from previous washings, The Coventry Mark 5 chain on this wash-bowl carrier is still giving trouble-free service after over three years' continuous service.

Working without lubrication and covered in coke dust, The Coventry Mark 5 chain on this conveyor headstock drive continually handles 90 tons of coke per day.

★ **runs easier**

★ **lasts longer**

★ **works better**

whatever the weather it's a fine chain!

RENOLD

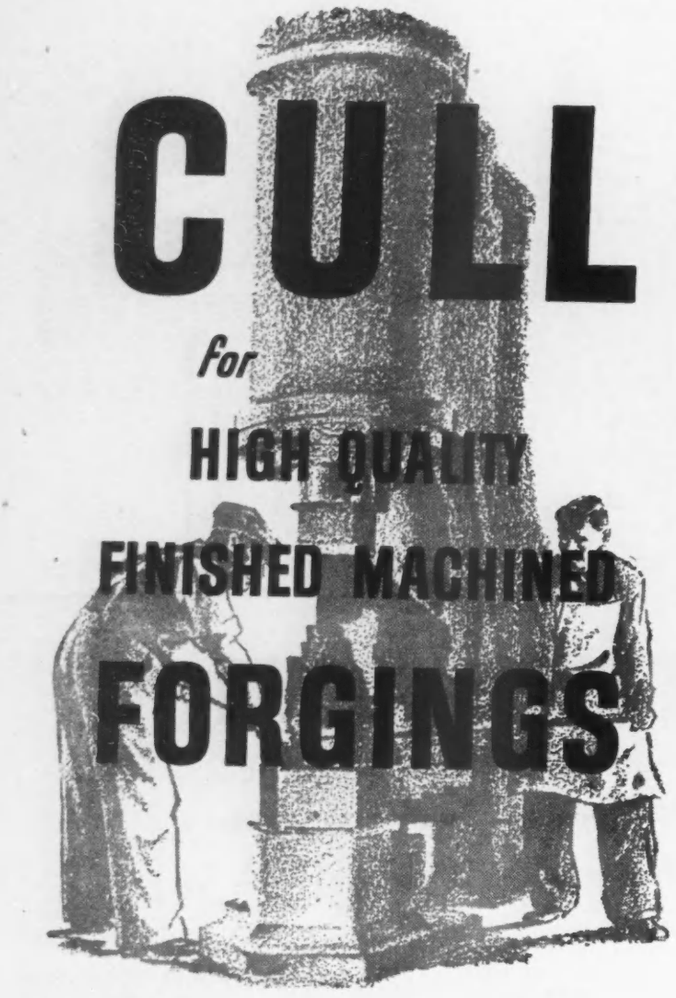
RENOLD CHAINS LIMITED · MANCHESTER

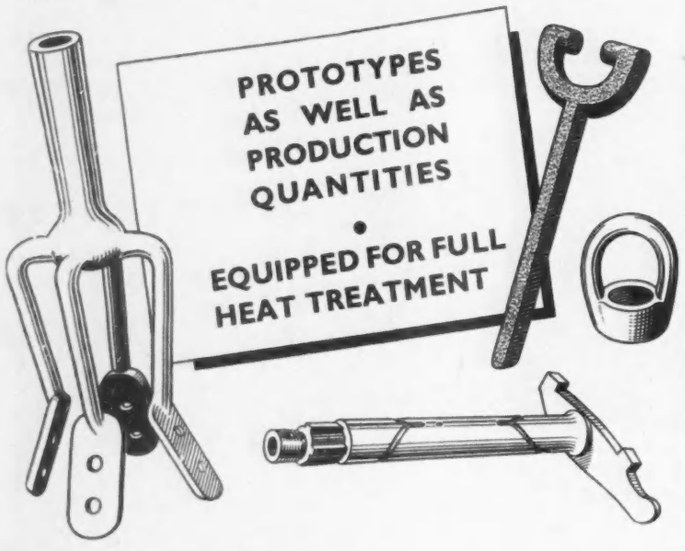
CULL

for

HIGH QUALITY FINISHED MACHINED

FORGINGS





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CAPSTAN PRODUCTS IN STEEL AND NON-FERROUS METALS

W. B. CULL & SONS LTD.

TENNANT ST., BIRMINGHAM, 15

Phone : Midland 6048-9 *Grams : CULANSONS, B'HAM*

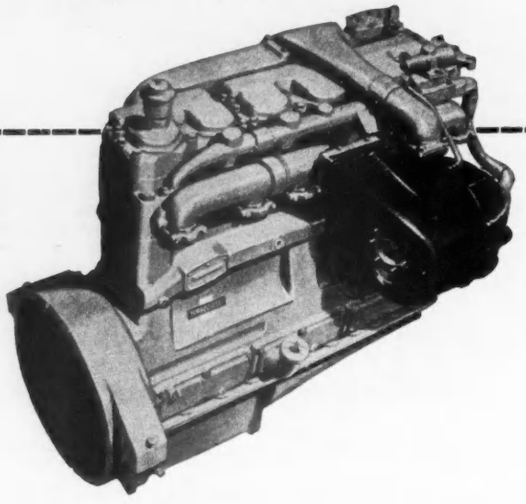
CONTRACTORS TO ADMIRALTY, M.O.S., A.I.D. APPROVED

ESTABLISHED 1875

Convert to

CUMMINS*

Profitable power



Now you can re-equip your plant with CUMMINS world-famous TURBODIESEL* engines and obtain more *power* . . . more *performance* and more *profit.*

CUMMINS TURBOCHARGING boosts horsepower without increasing engine capacity.

CUMMINS PT* fuel system is simpler and more efficient than any other diesel *or* petrol fuel system.

CUMMINS diesel engines are available for sterling from 150–335 b.h.p. Complete nation-wide servicing facilities are available to ensure maximum earning capacity for your CUMMINS diesel engines *all* the time.

CUMMINS gives you the BIG plus **MORE PROFIT**

CUMMINS DIESEL SALES & SERVICE LTD.

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Mayfair 9090

SPARES & SERVICE: HUNSBURY WORKS, NORTHAMPTON
Northampton 5262

* *Trade Marks of Cummins Engine Company, Inc.*

conveyed safely

To convey safely *care* has to be taken; and with conveyor belting the right point at which *care* should be taken is at the design, development and manufacturing stages. After that it should take *care* of itself, the people who work with it and the load it carries. The unique research and manufacturing facilities of Rubber Improvement Ltd. make certain that Leonex P.V.C. Multiply Conveyor Belting is produced with such *great care* that long life, dependability and safety are ensured.

LEONEX "Green for Safety" P.V.C. Conveyor Belting, standard quality (32 oz. duck) and super impact resistant quality (42 oz. duck).

RILON "Green for Safety" flexible and high tensile belting, incorporating high tenacity rayon.

LEONEX and **RILON** incorporate special abrasion and tear resistant covers.

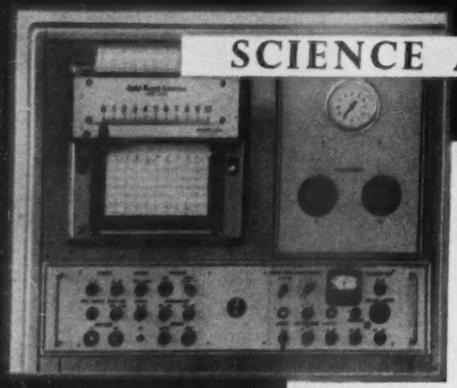
LEONEX
Green for safety
P.V.C. MULTIPLY ANTI-STATIC FIRE-RESISTANT
CONVEYOR BELTING

ANOTHER RIL PRODUCT

RUBBER IMPROVEMENT LIMITED

Rilex Works · Wellingborough · Northants · Tel: Wellingborough 2218

SCIENCE AND THE STEEL TUBE AGE : 2



QUANTOMETER

In the great, modern steel and tube works of Stewarts and Lloyds at Corby the daily production of 2,700 tons of steel calls for rapid and accurate analysis of samples.

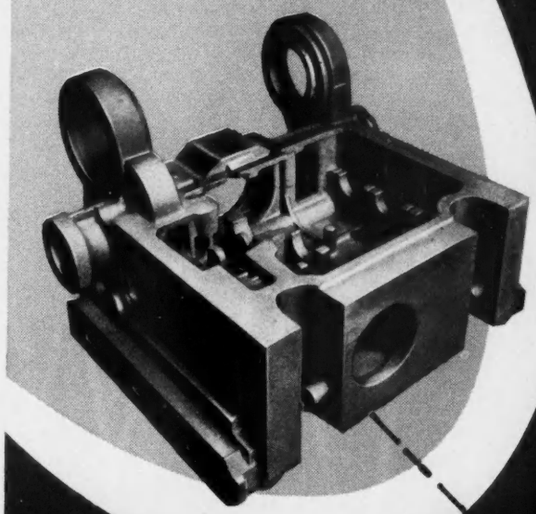
Chemical analysis has to some extent been replaced by the photographic spectrograph but to meet the need for still greater speed there is now in use at Corby an automatic direct-reading spectrographic analyser known as a Quantometer.

A small sample of steel, taken during a melt, is dispatched to the laboratory by pneumatic conveyor and an electric spark is struck between the sample and a counter electrode. The light from the spark is focused upon a special diffraction grating which produces an extended spectrum. The significant spectral lines fall on photomultipliers which measure their density. A quantitative assessment of the amount of each element is then recorded upon a chart (visible in the small illustration). The whole operation takes less than two minutes and this system provides a constant and rapid check on the quality of the steel.

STEWARTS AND LLOYDS
LIMITED
GLASGOW · BIRMINGHAM · LONDON

S&L

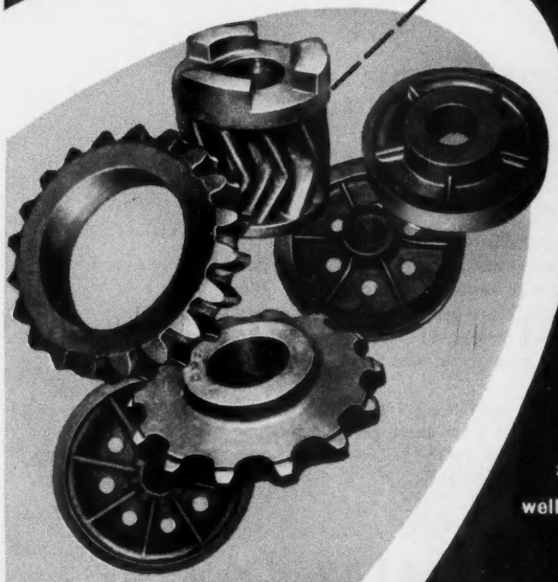
The sign of [illegible]ty



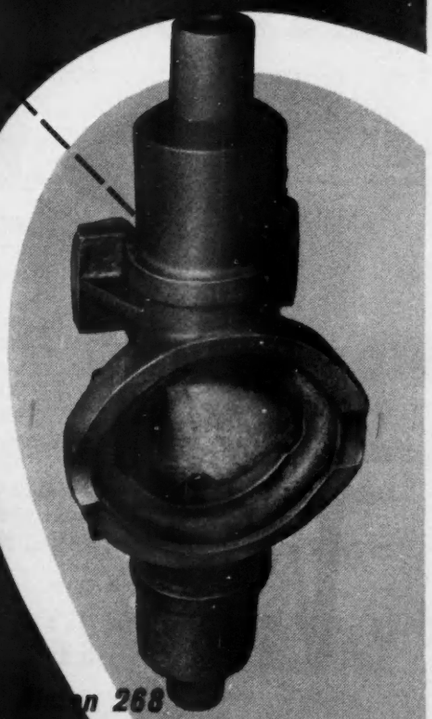
Sound and true carbon steel castings are the hallmark of A.F.C.

Our metallurgical laboratory exercises a strict control . . . Gamma Ray tests and inspection ensure soundness . . . pattern and drawing tests guarantee accuracy.

ALSTON FOUNDRY CO. LTD



Specialists in the casting of crane and railway axle and gear boxes, buffers, guides, spur and bevel wheels also pinion blanks - in addition, of course, to our well-known coal mining machinery castings.



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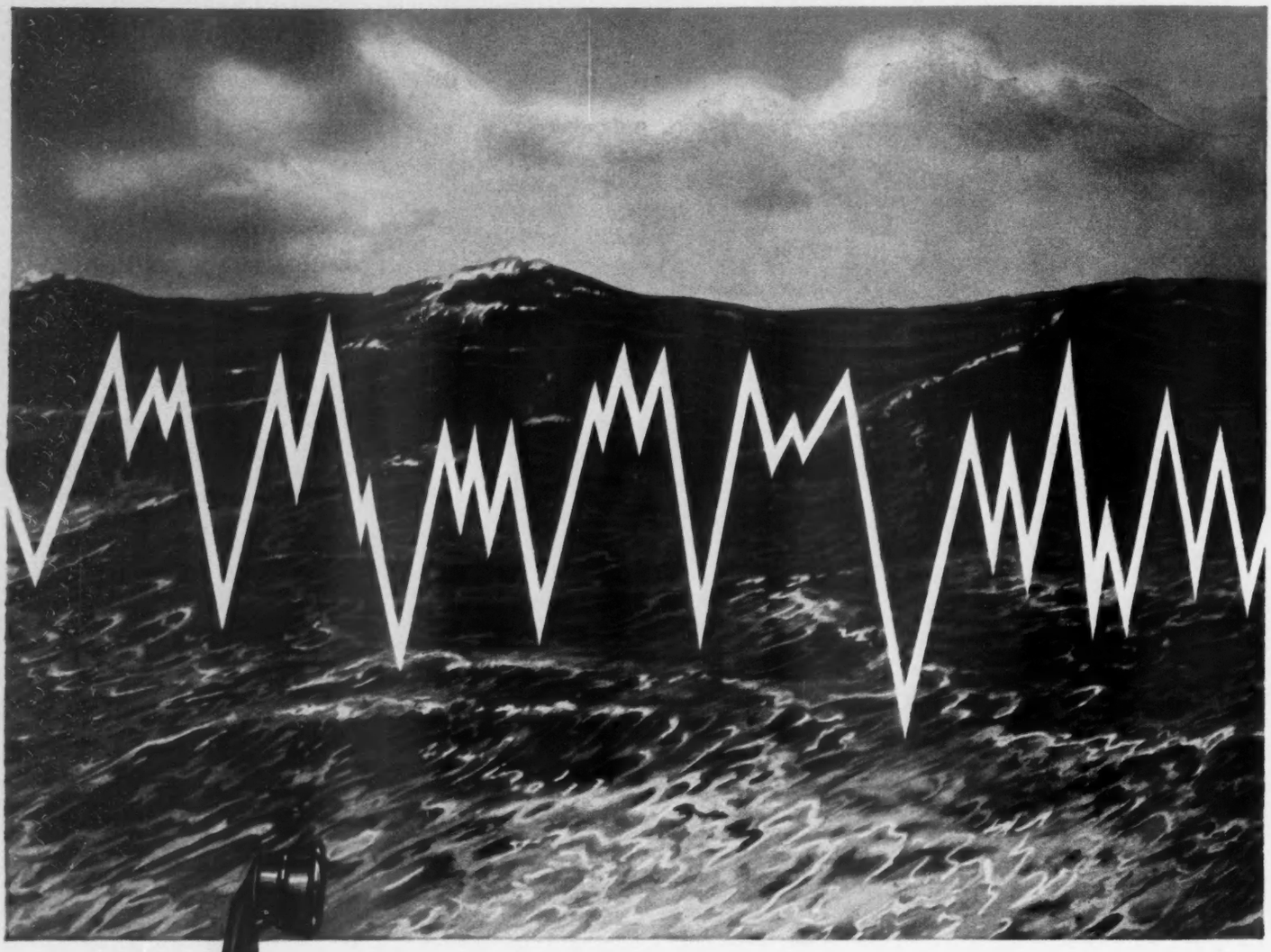

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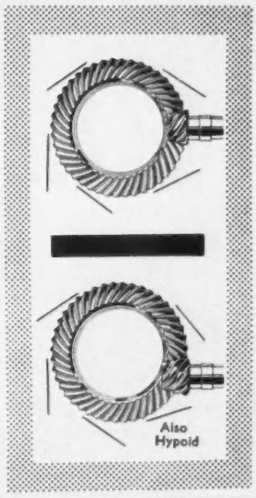

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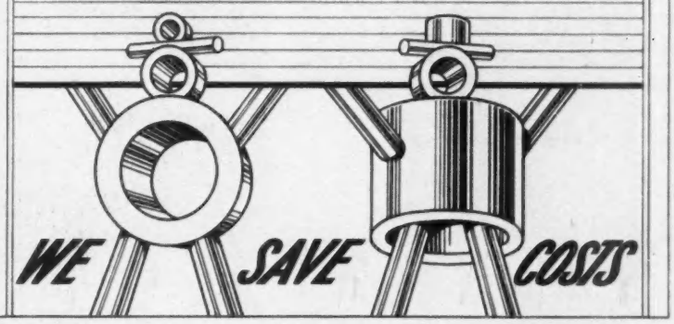

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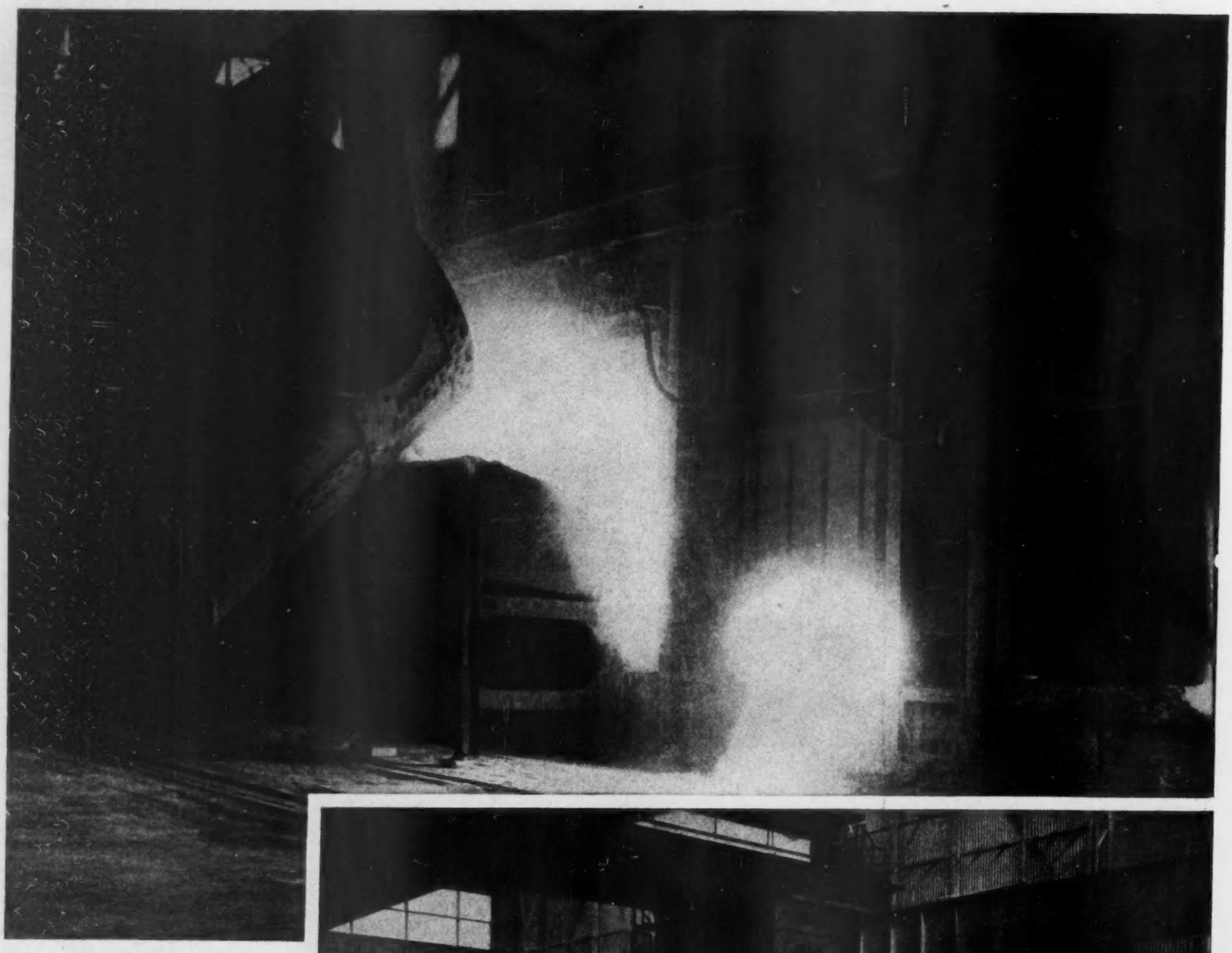

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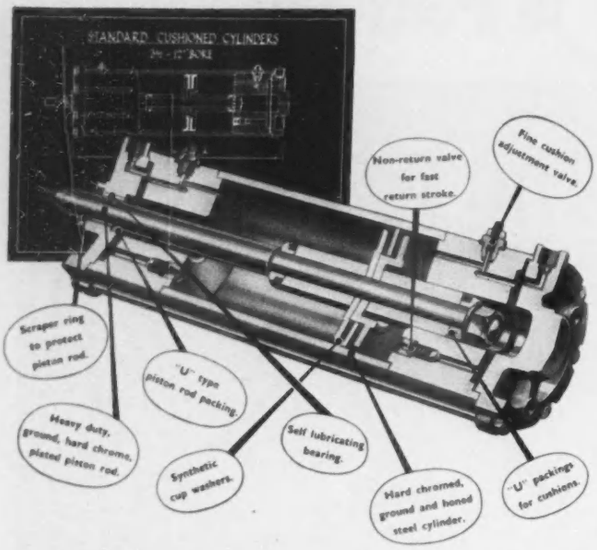
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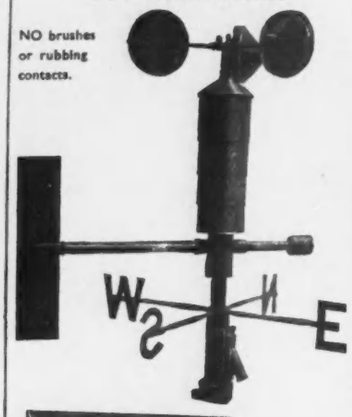

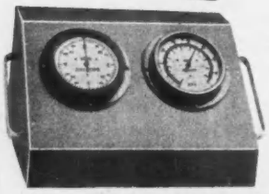

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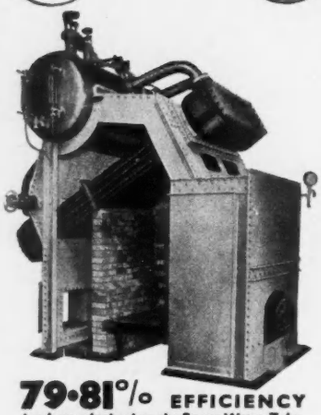

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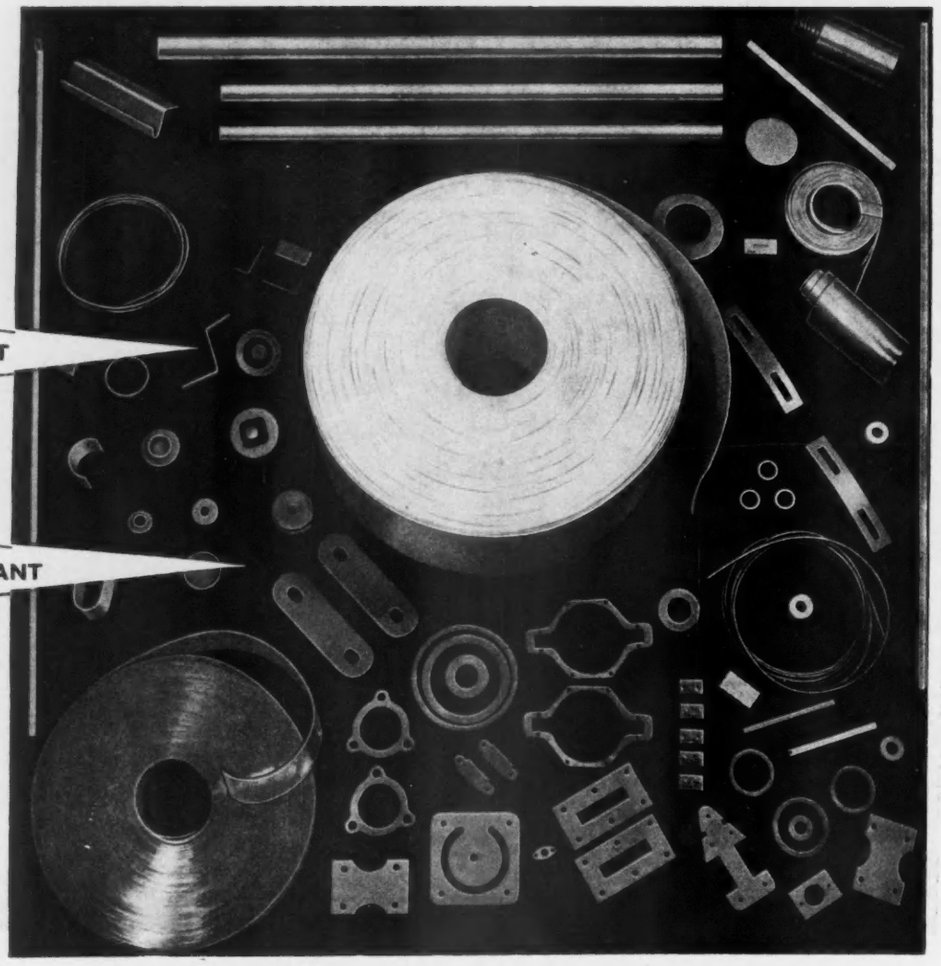

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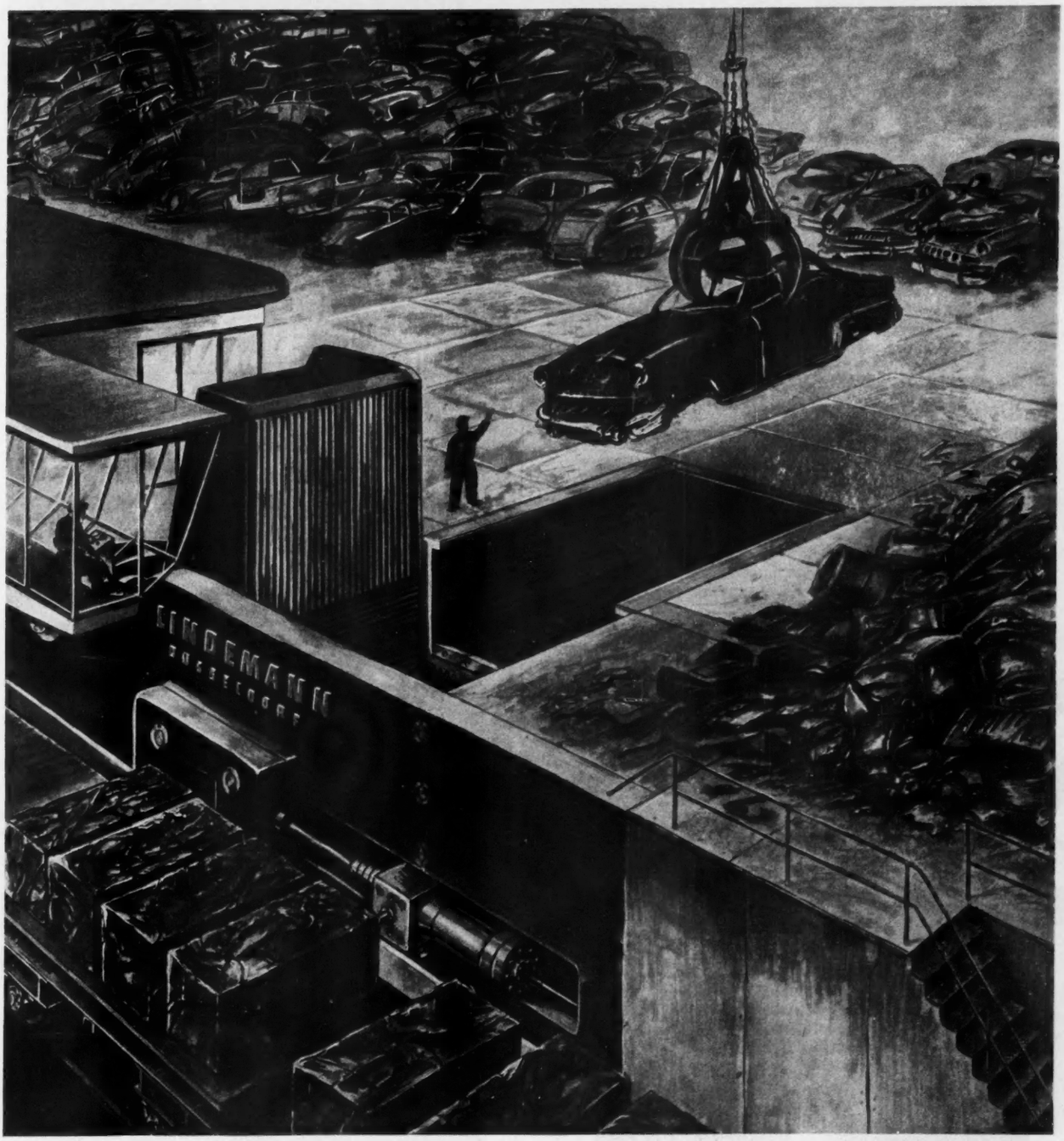

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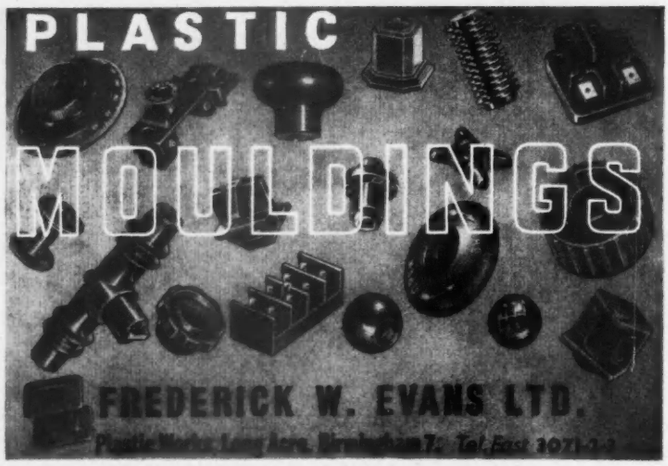

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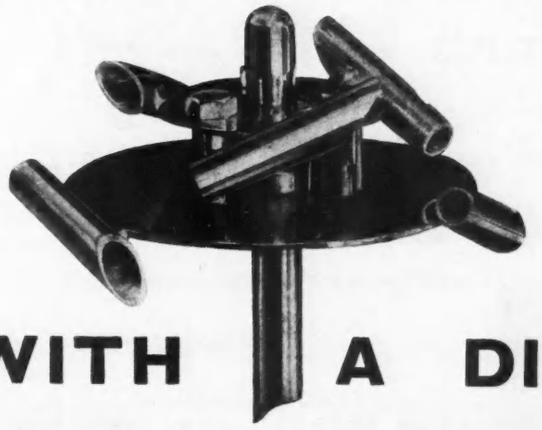

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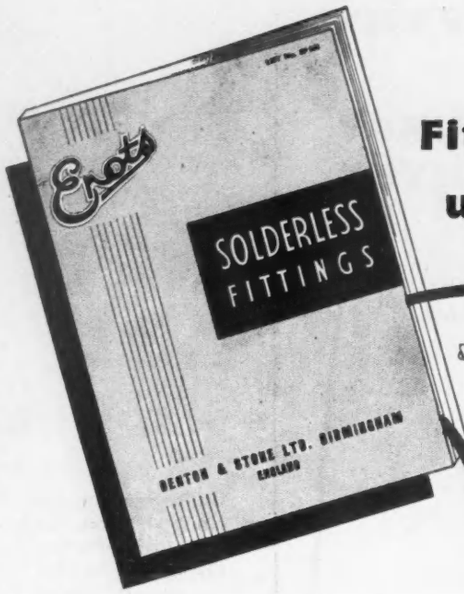
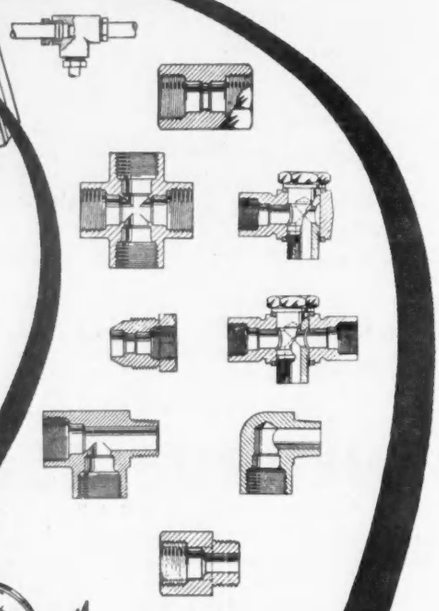


Fitted any good unions lately?



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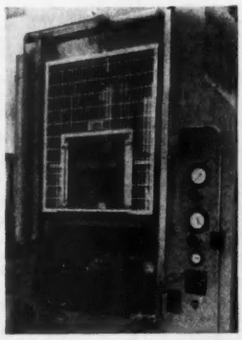

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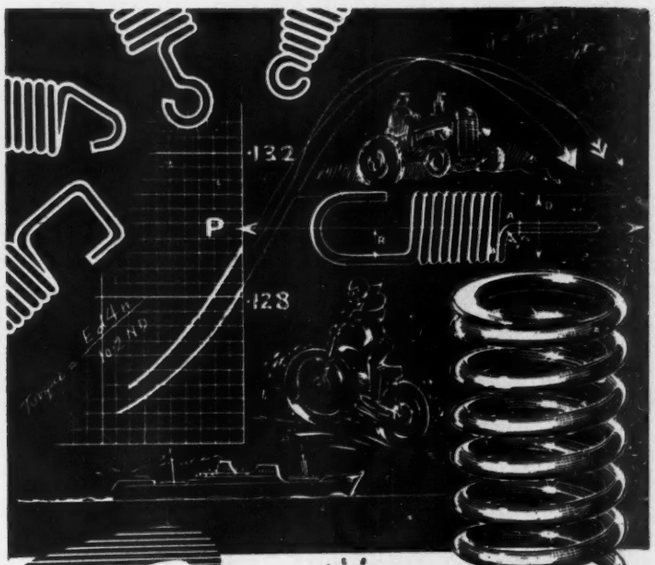

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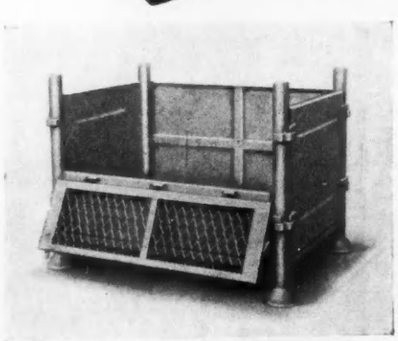

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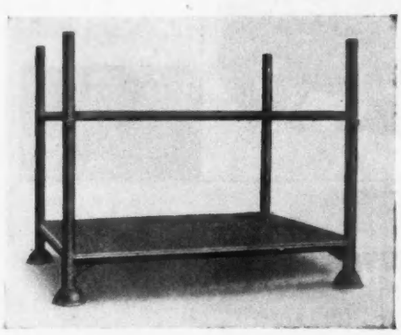

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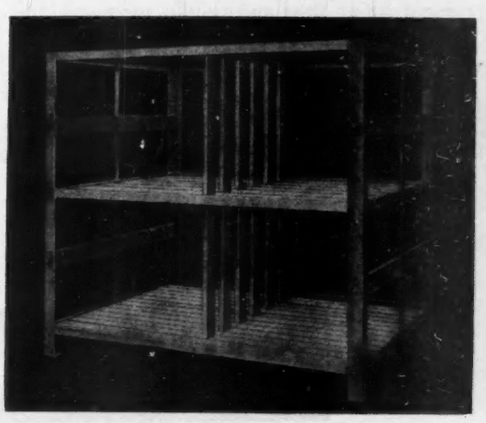

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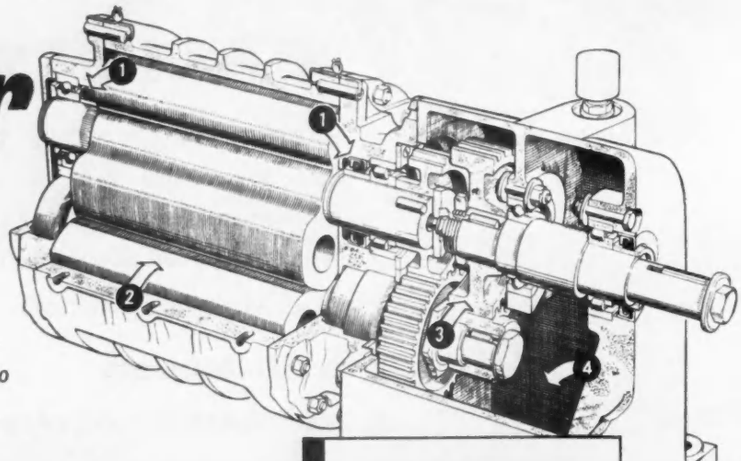

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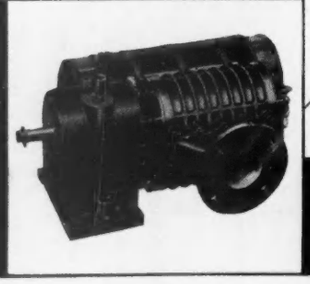

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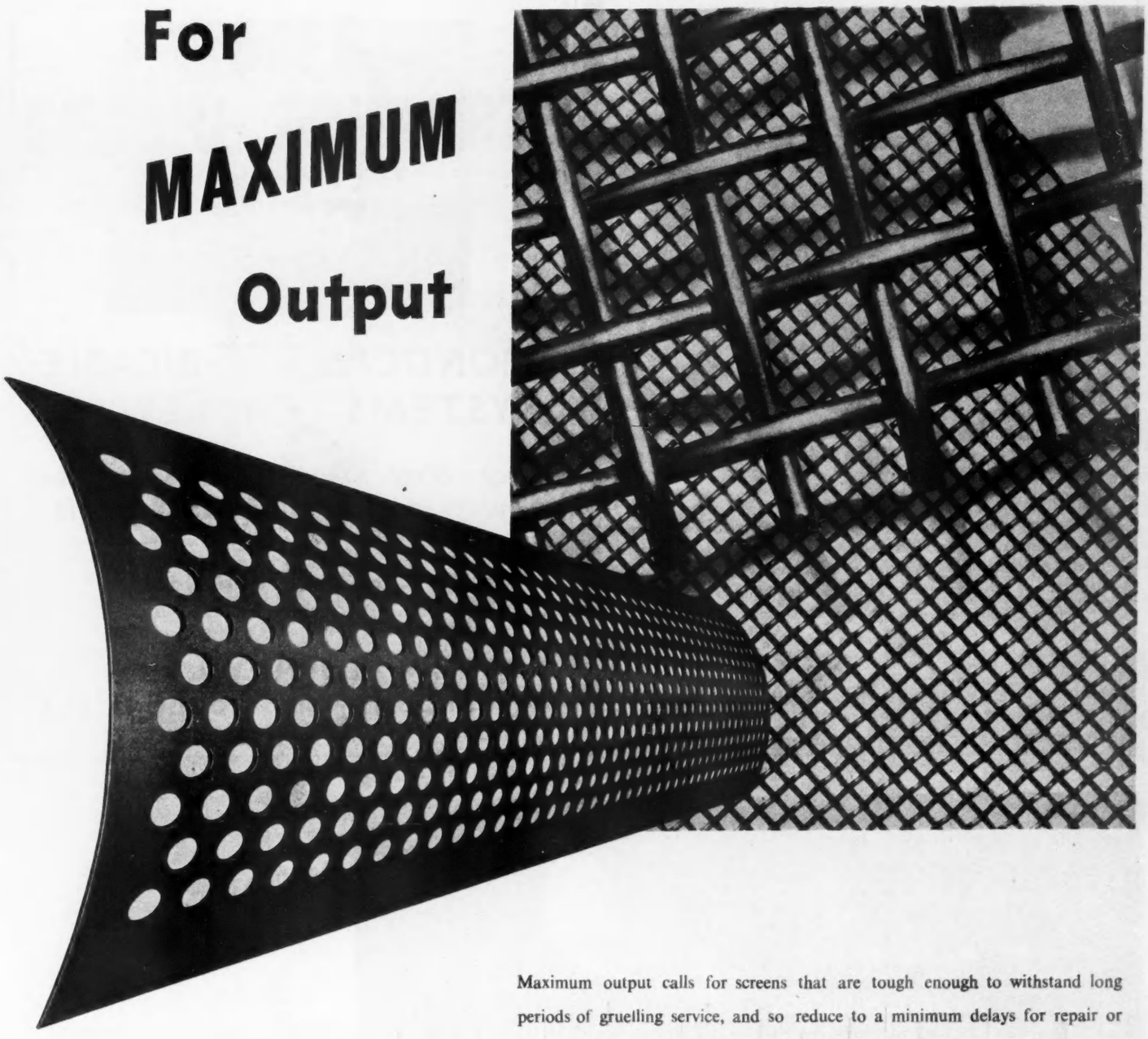

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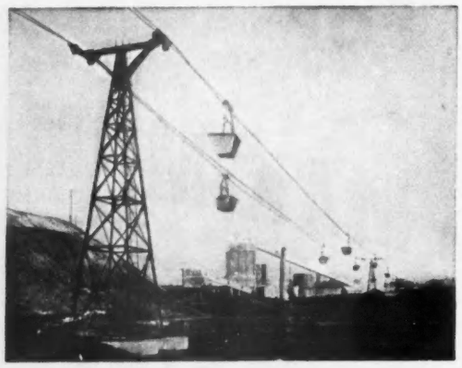

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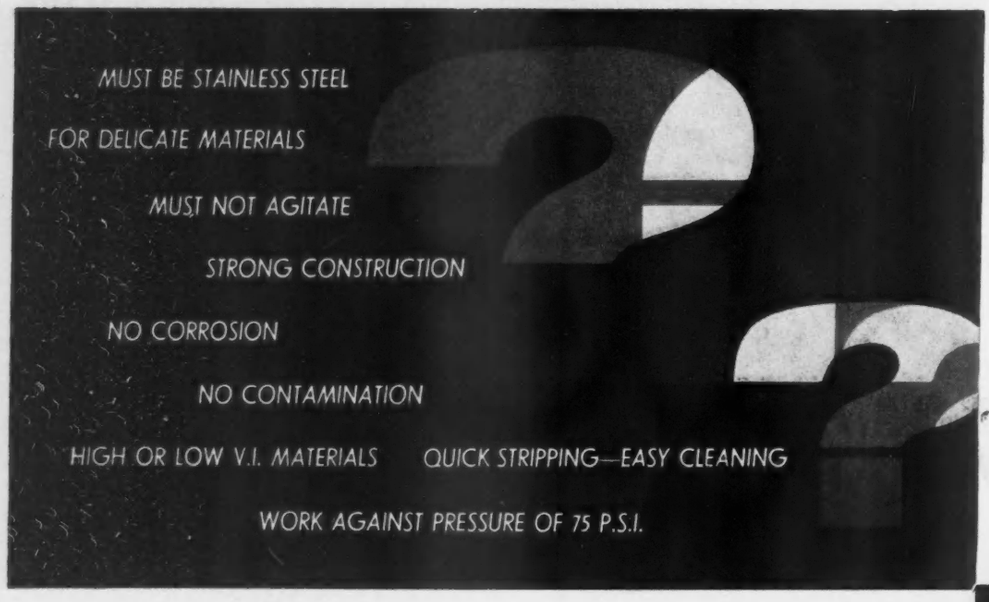

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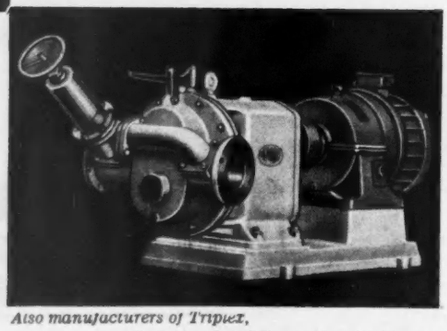

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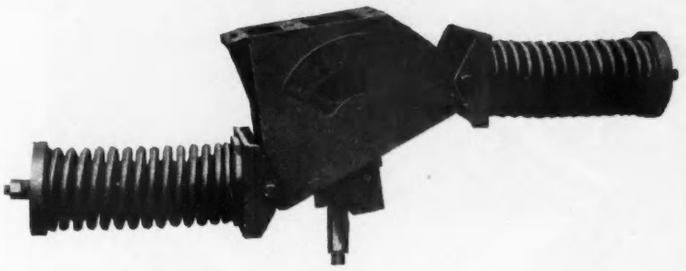

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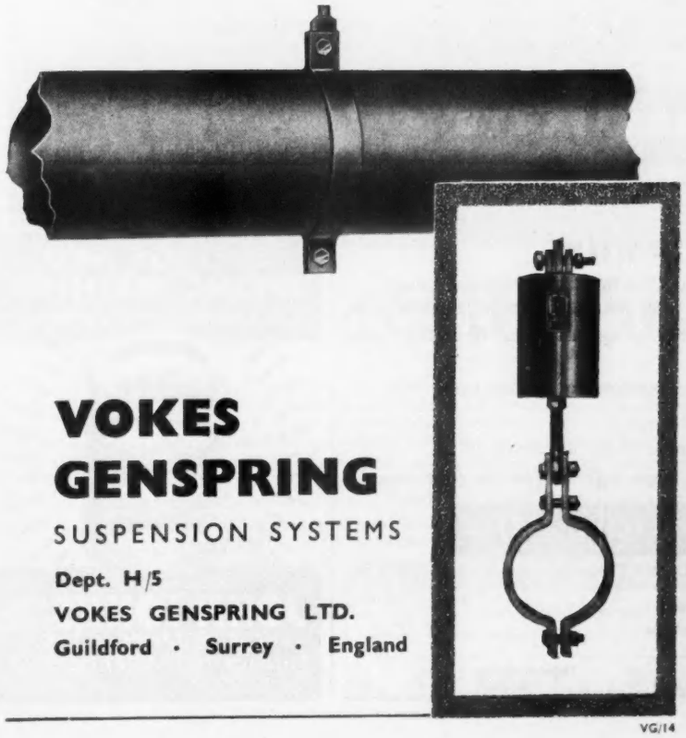

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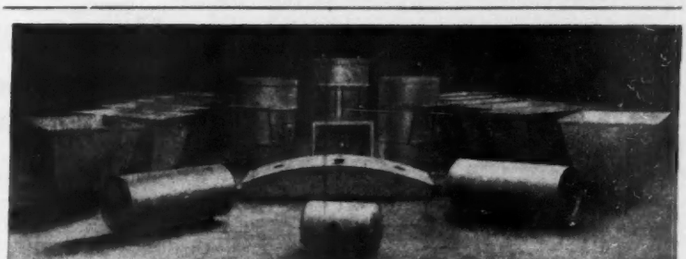

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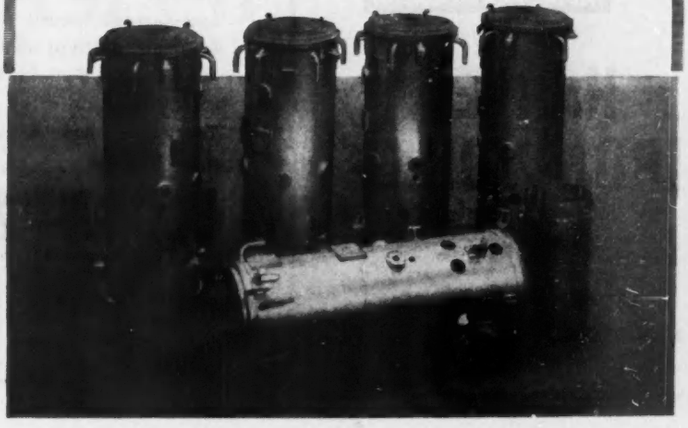

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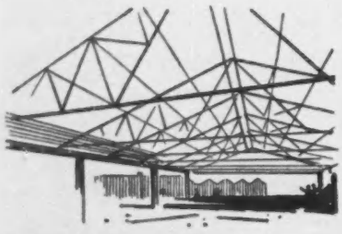

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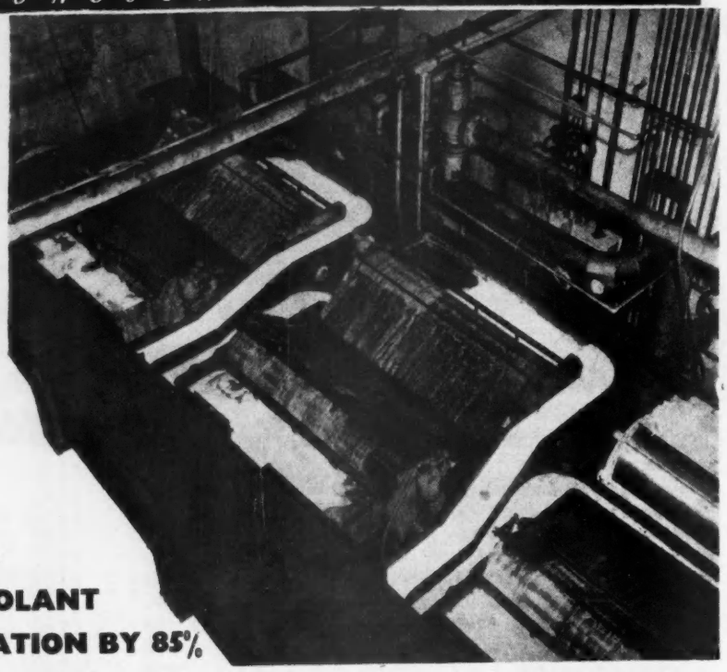

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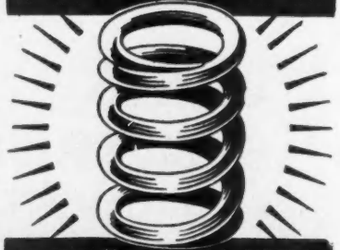

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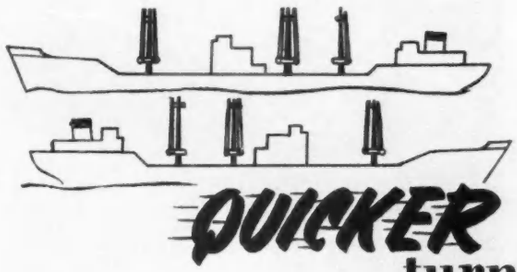

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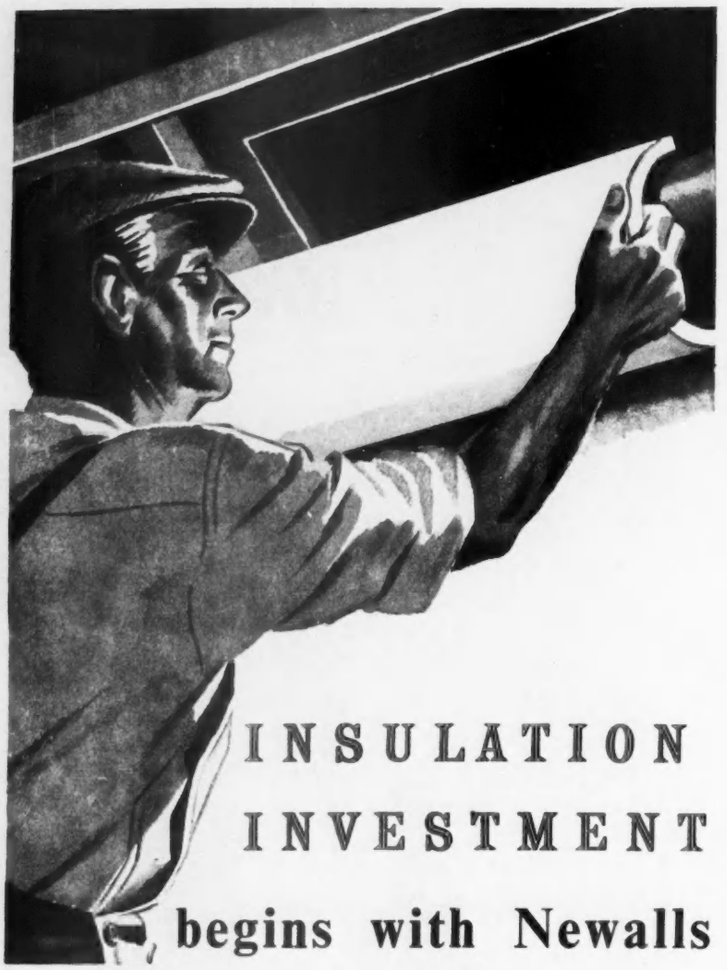

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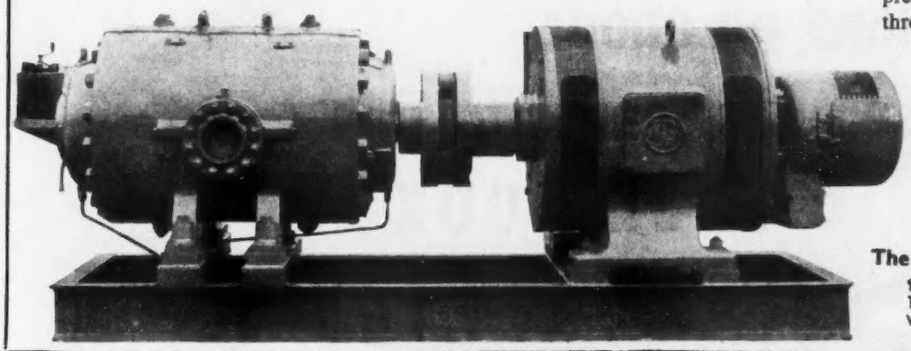

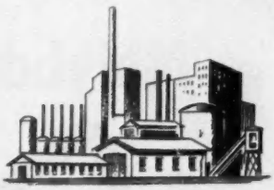

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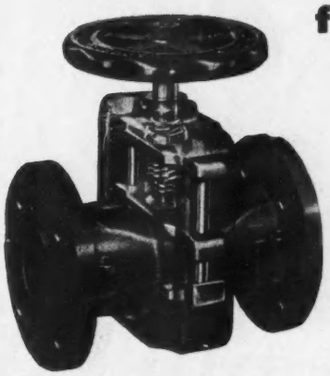

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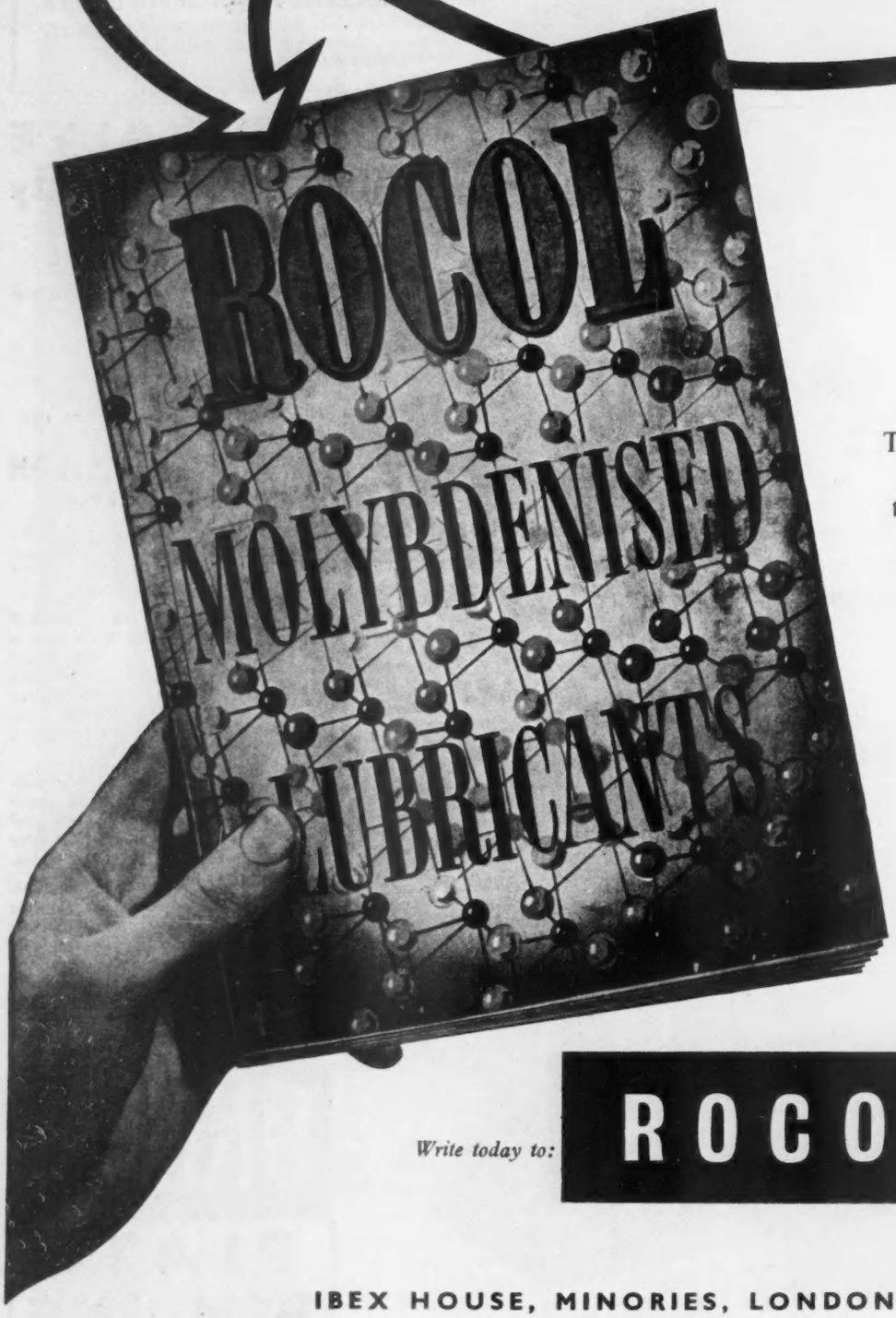

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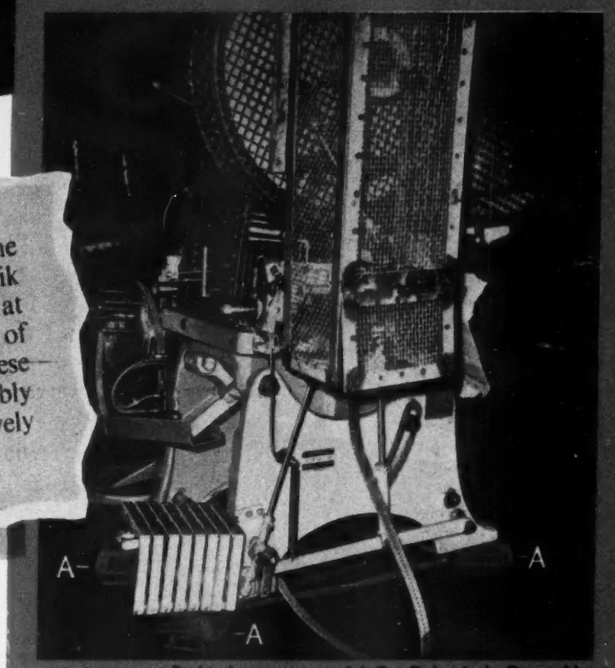
"... and an interesting feature of the installation is the provision of Metalastik Cushyfoot anti-vibration mountings as seen at 'A'. Compared with the conventional practice of bolting the presses directly to the floor, these mountings have resulted in a considerably longer life between regrinds of the relatively costly follow-on tools which are used."

from:— "MACHINERY"
May 6, 1955



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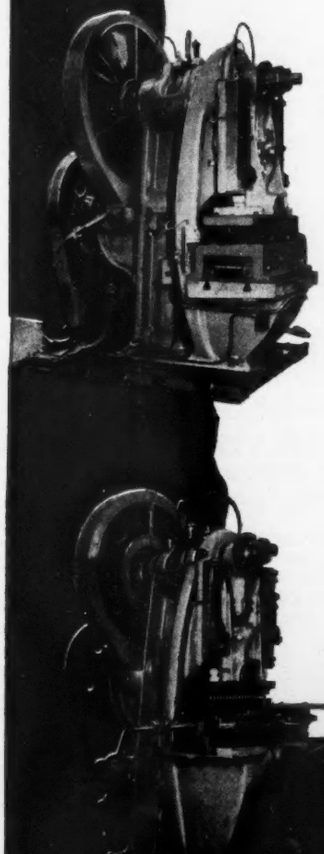
Cushyfoot
mountings on presses



The illustrations show three presses mounted on 'Cushyfoot' mountings, where they have been most successful in reducing noise and shock, thus bringing benefit not only to the operators but also to the rest of the staff and — sometimes — to neighbours. Moreover, as the cutting from 'Machinery' shows, press tools have been found to last longer between regrinds.

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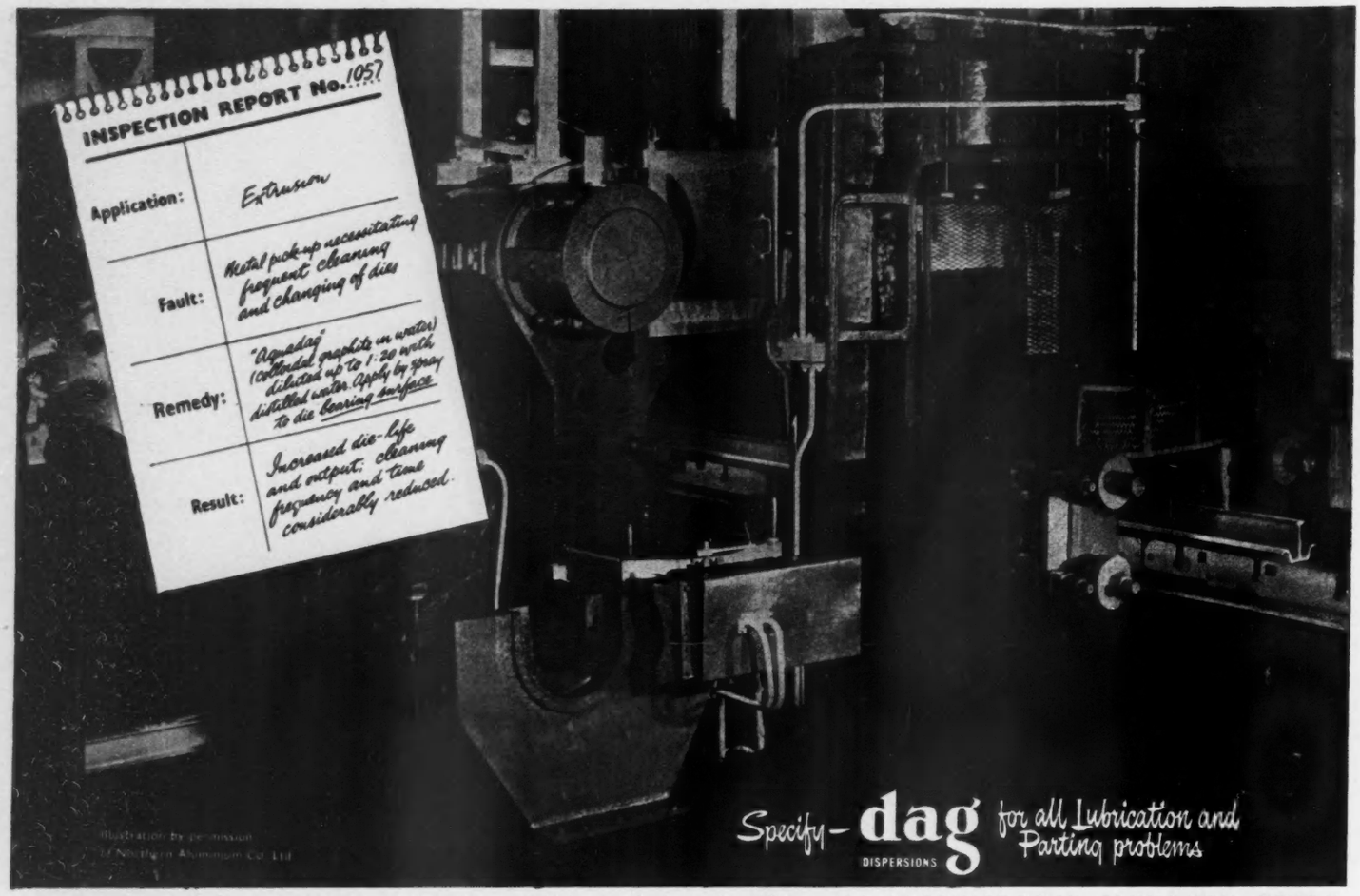
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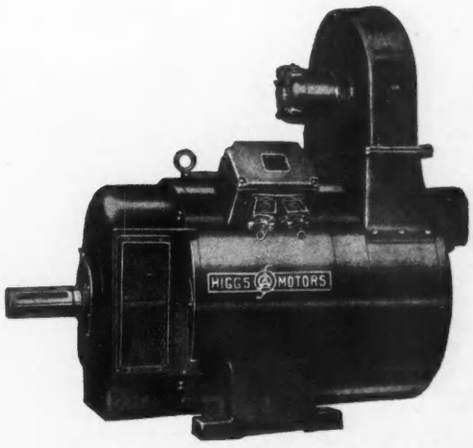

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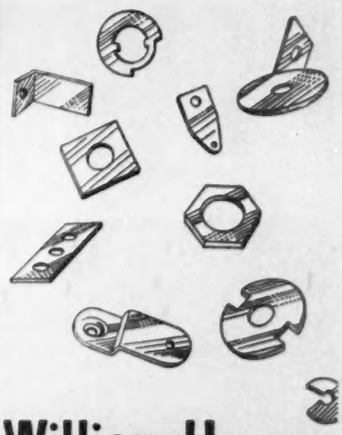

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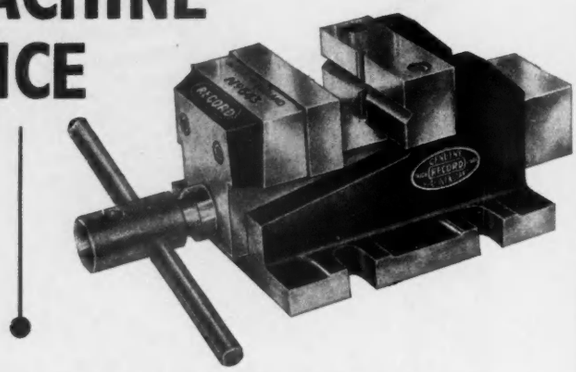

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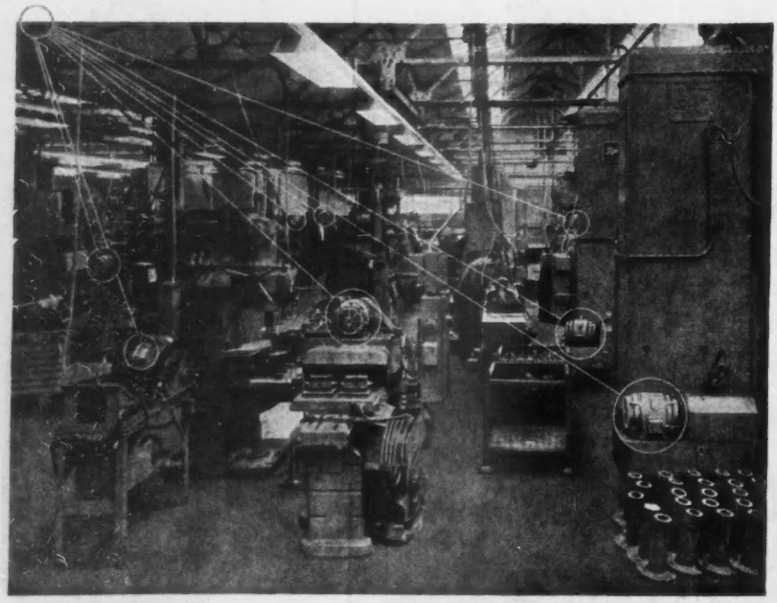

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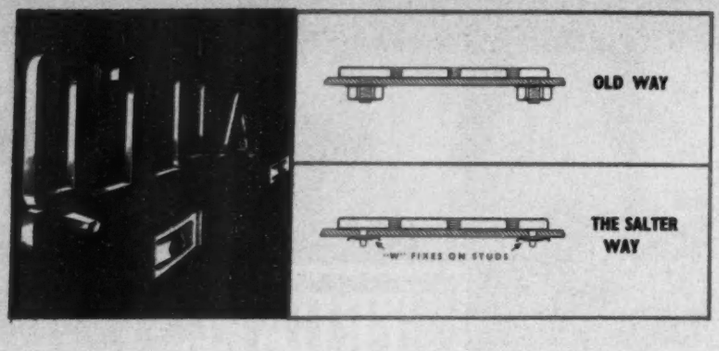

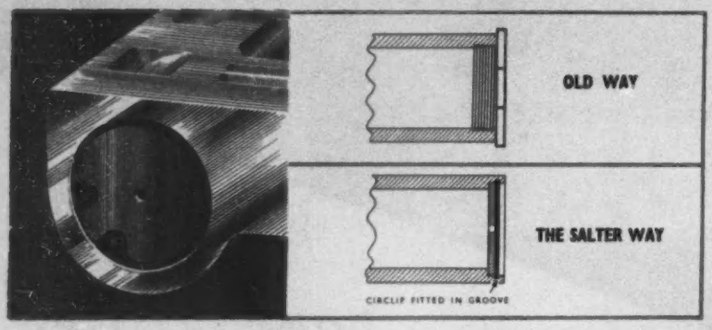

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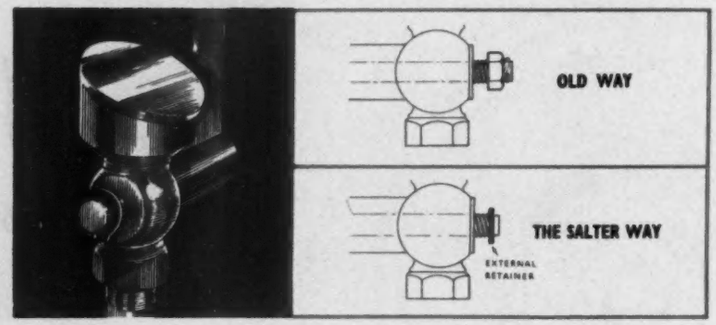

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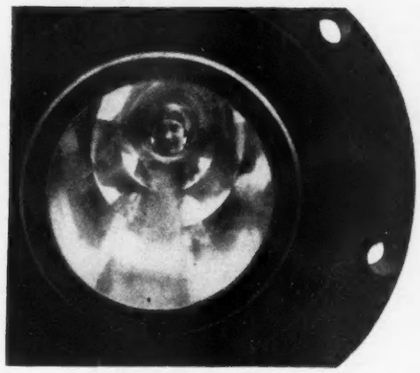

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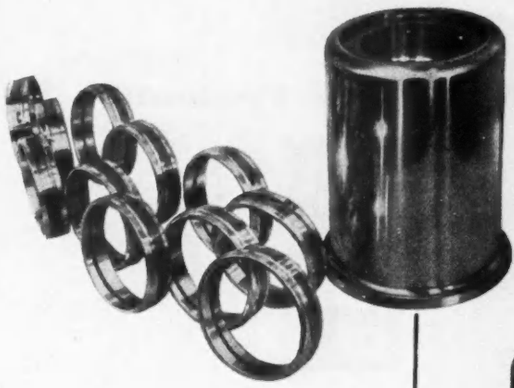

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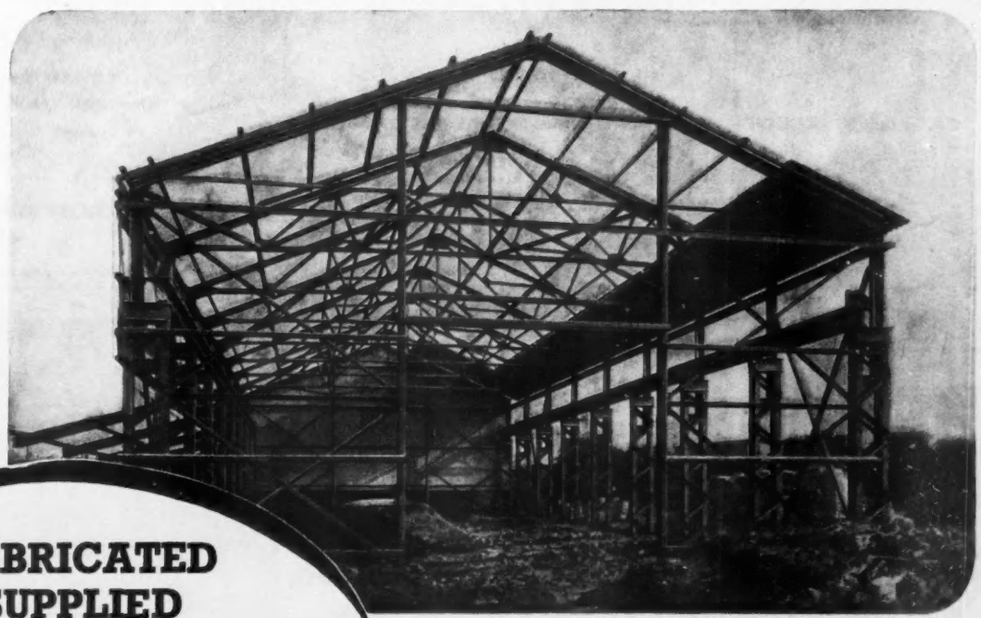

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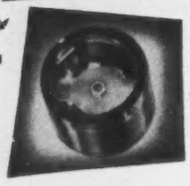

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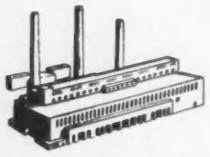

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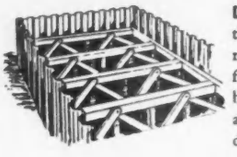

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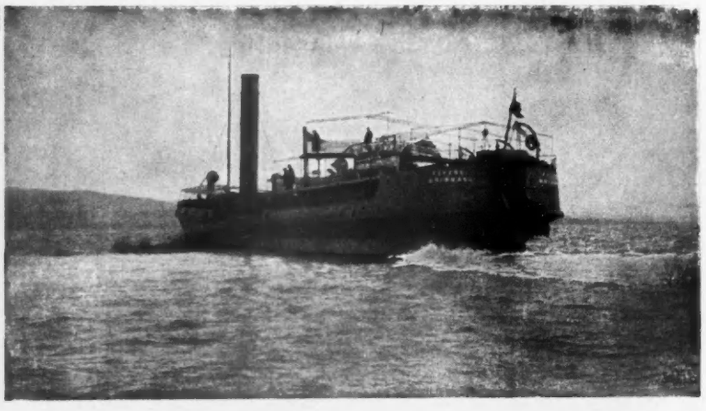

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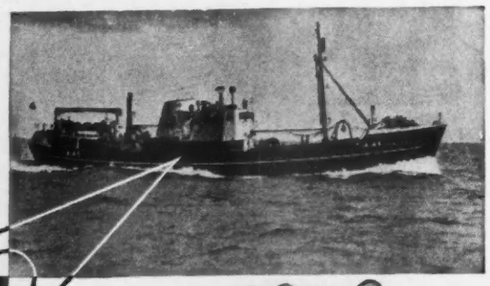

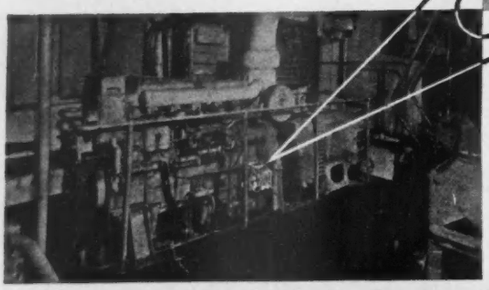

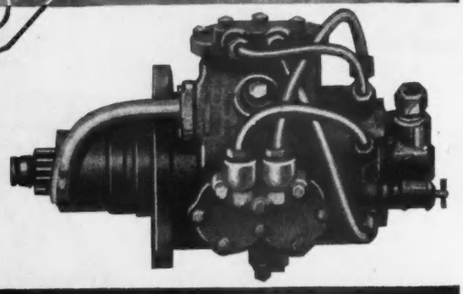

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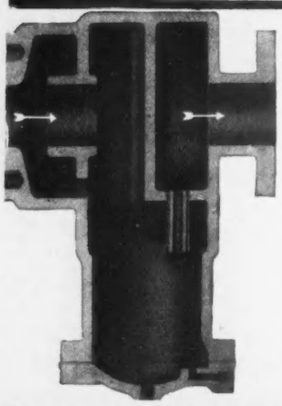

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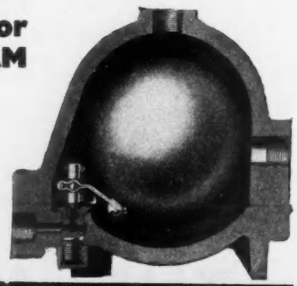

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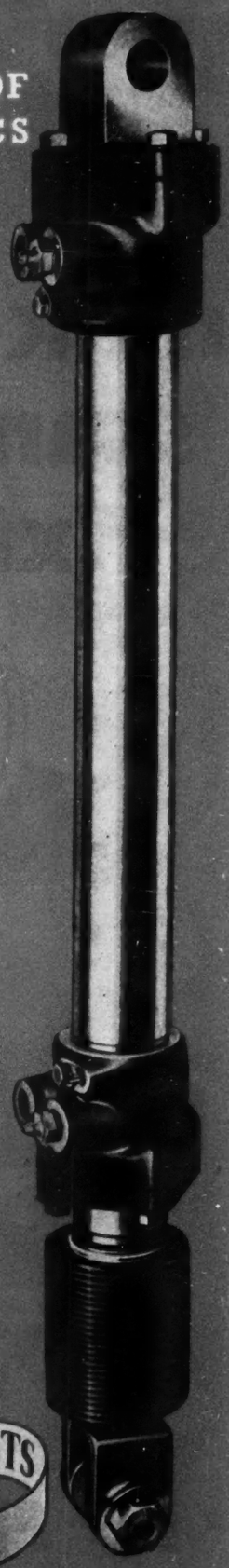

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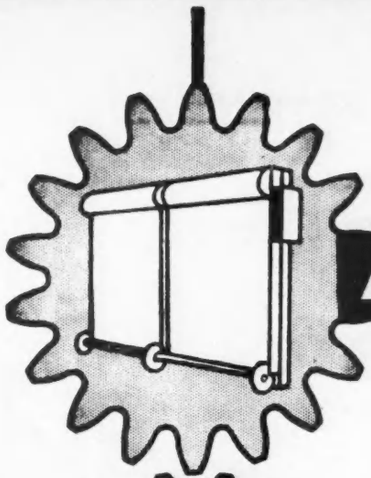

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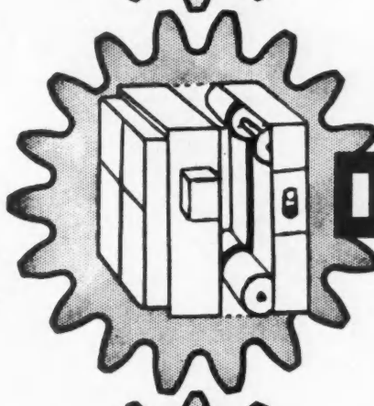

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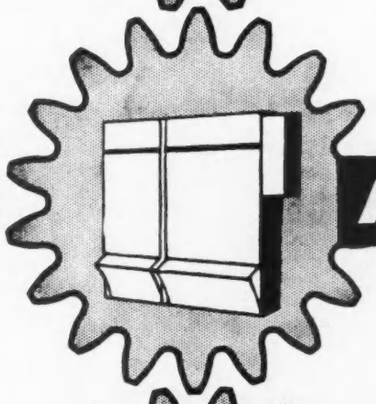

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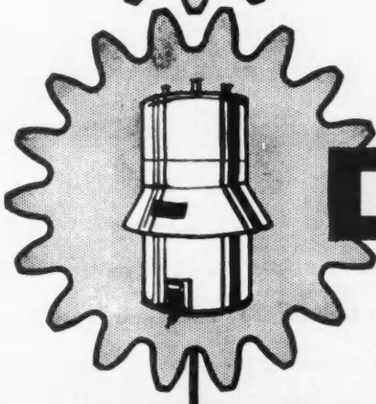

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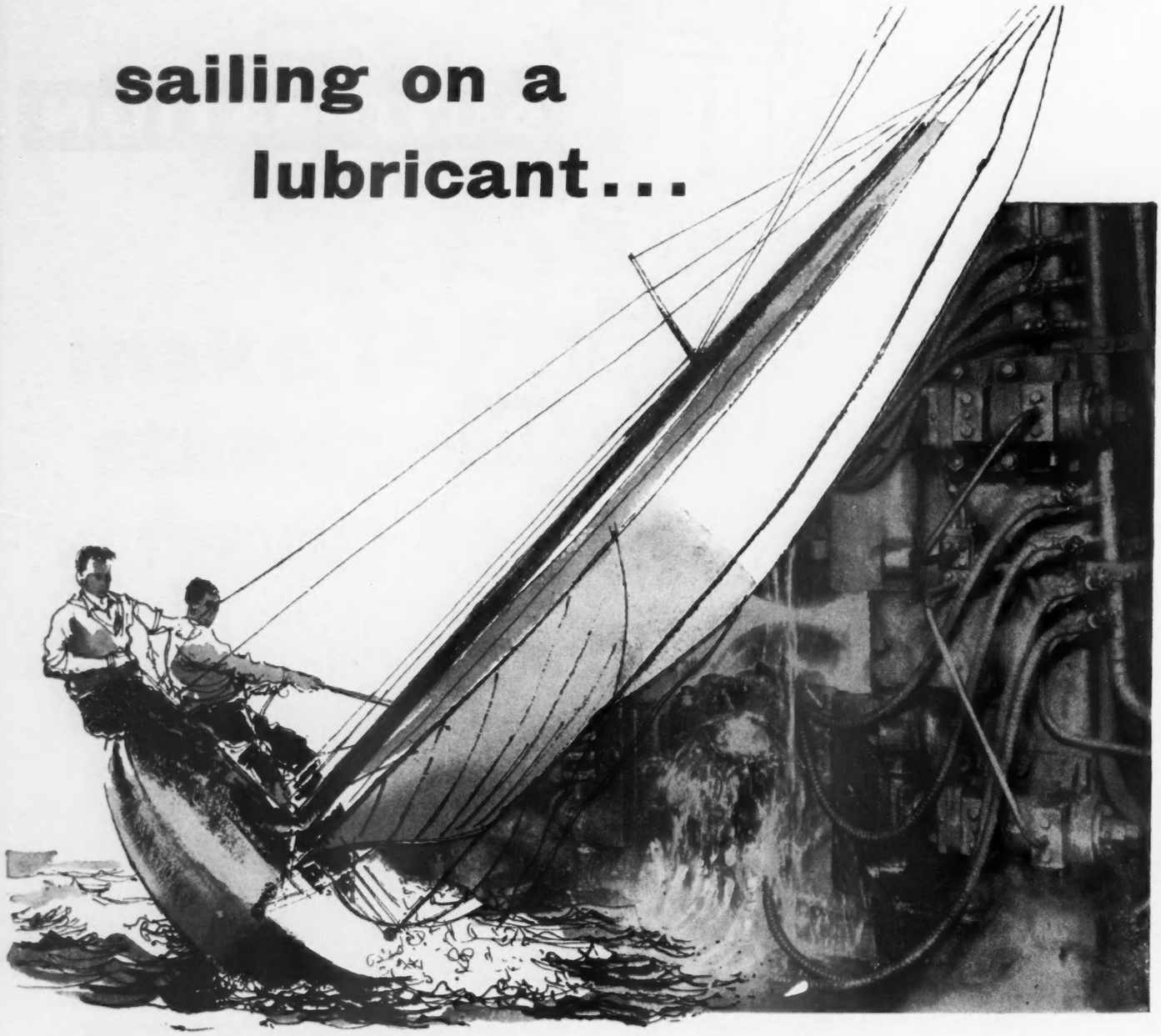

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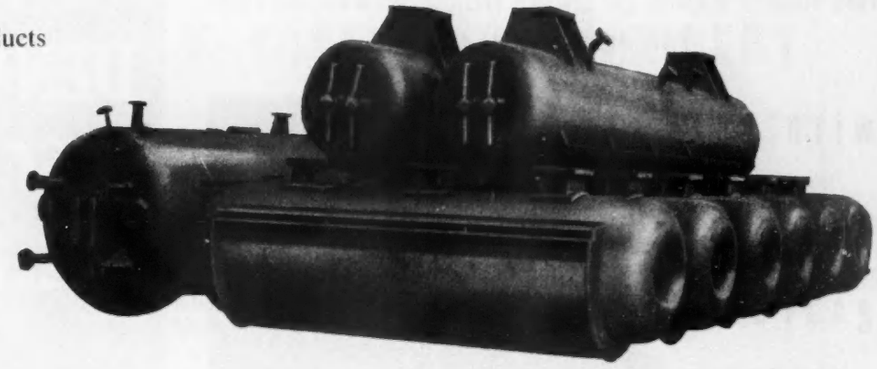

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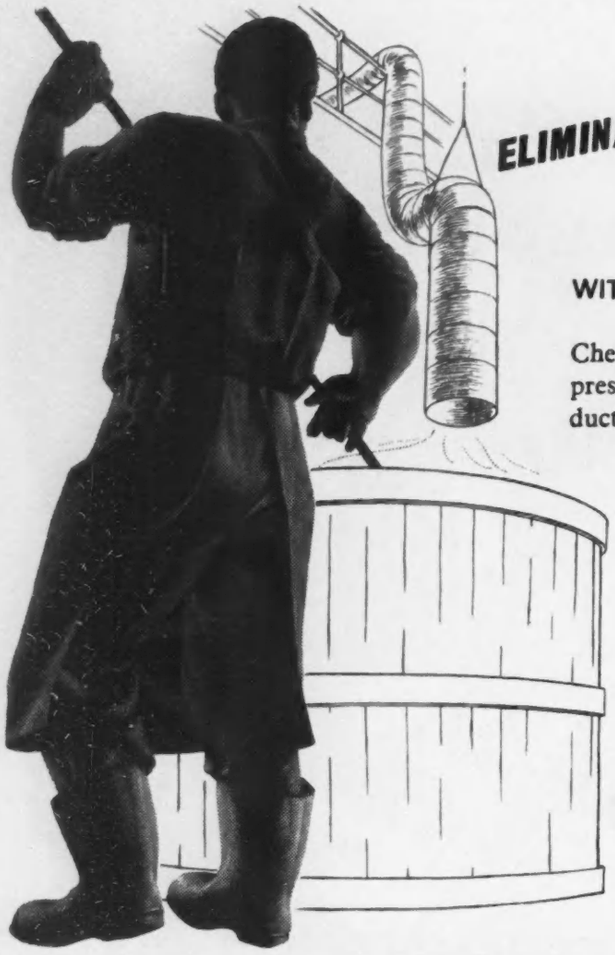

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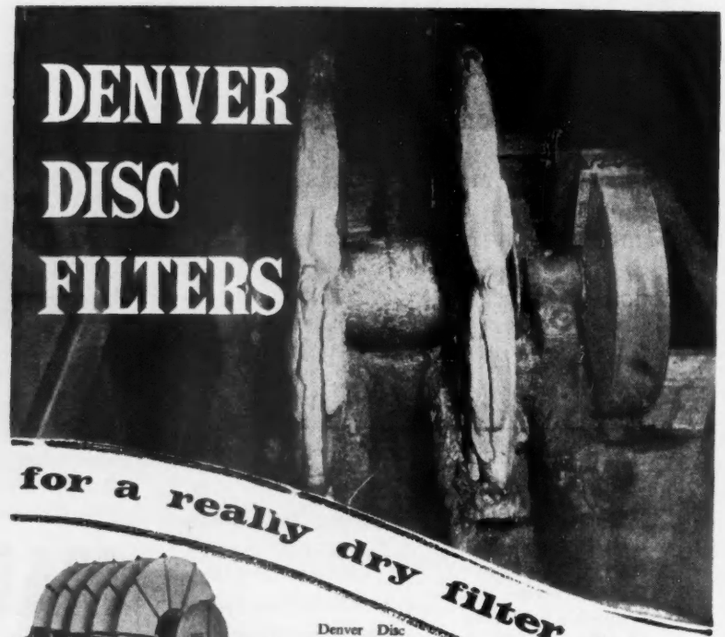

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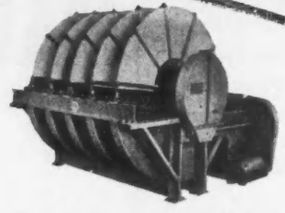

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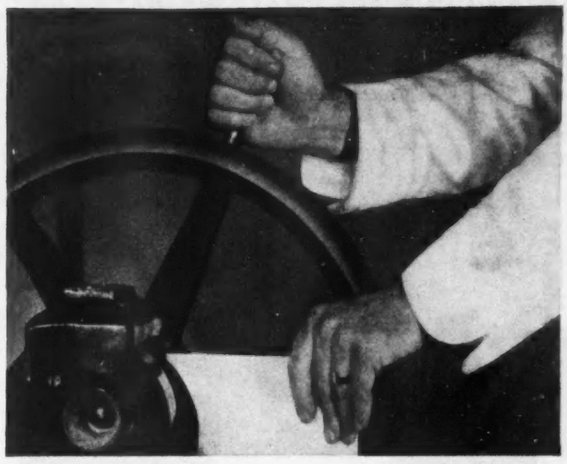

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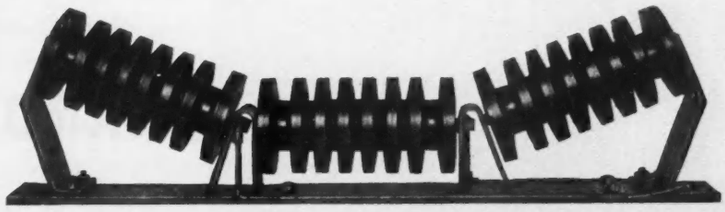

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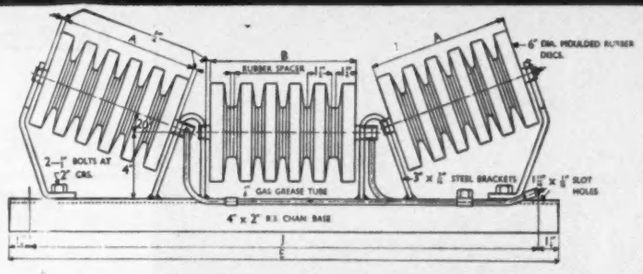
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18" "	6"	6"	28"	25½"
20" "	6"	8"	30"	27½"
22" "	7"	8"	32"	29½"
24" "	7½"	9"	34"	30½"
30" "	8½"	9"	36"	33½"
36" "	9½"	10"	42"	39½"
42" "	10½"	10"	48"	45½"
48" "	10½"	10½"	48"	47"
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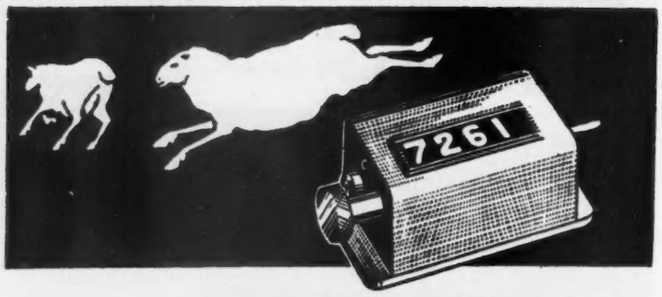

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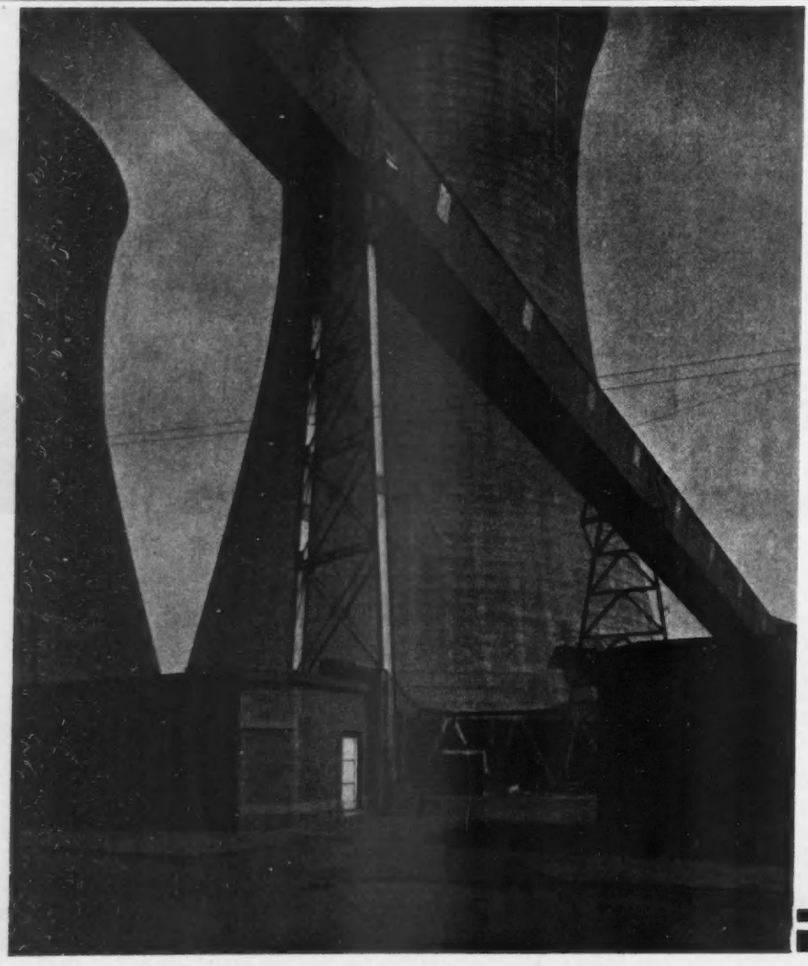

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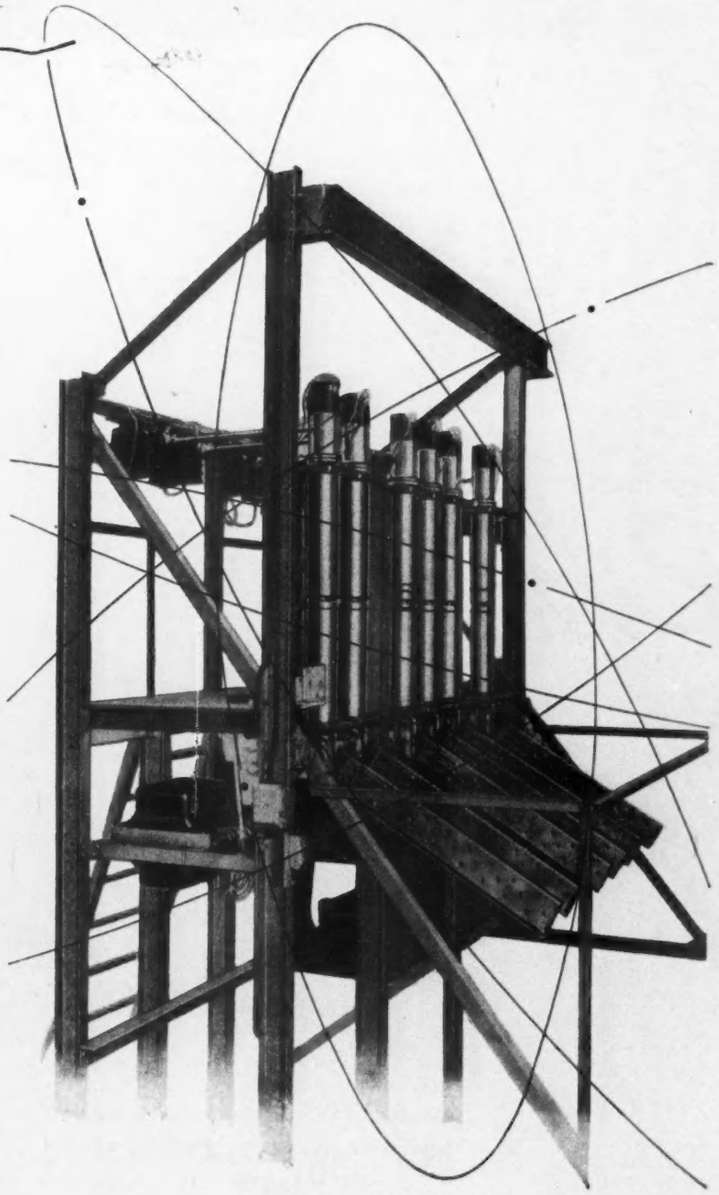

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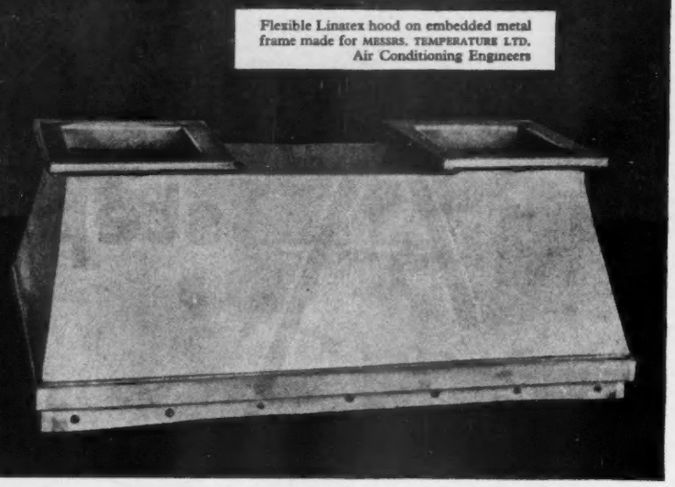

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FAB. 6

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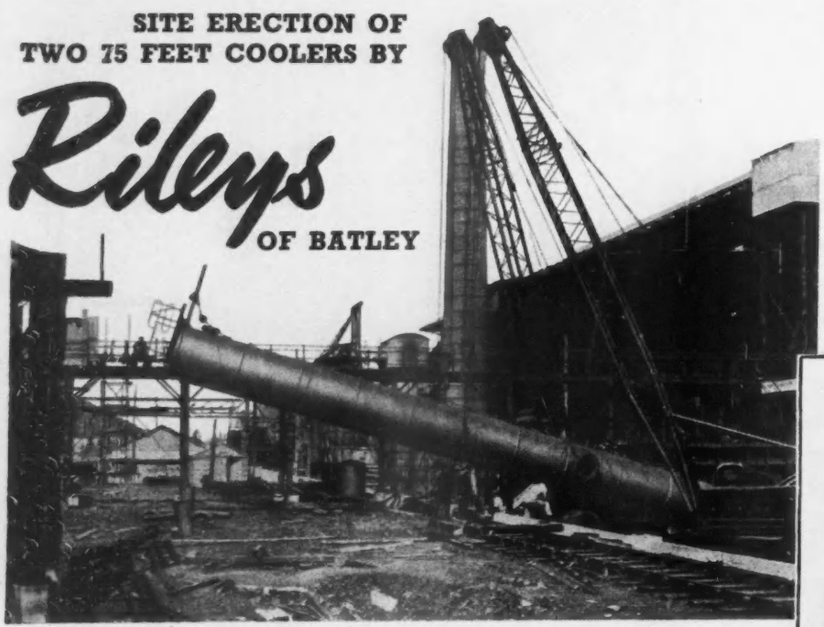

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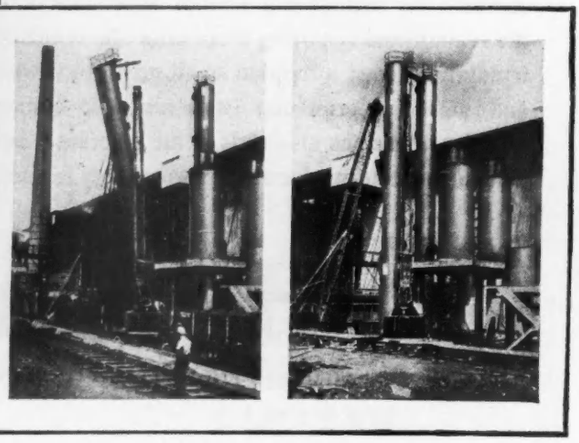

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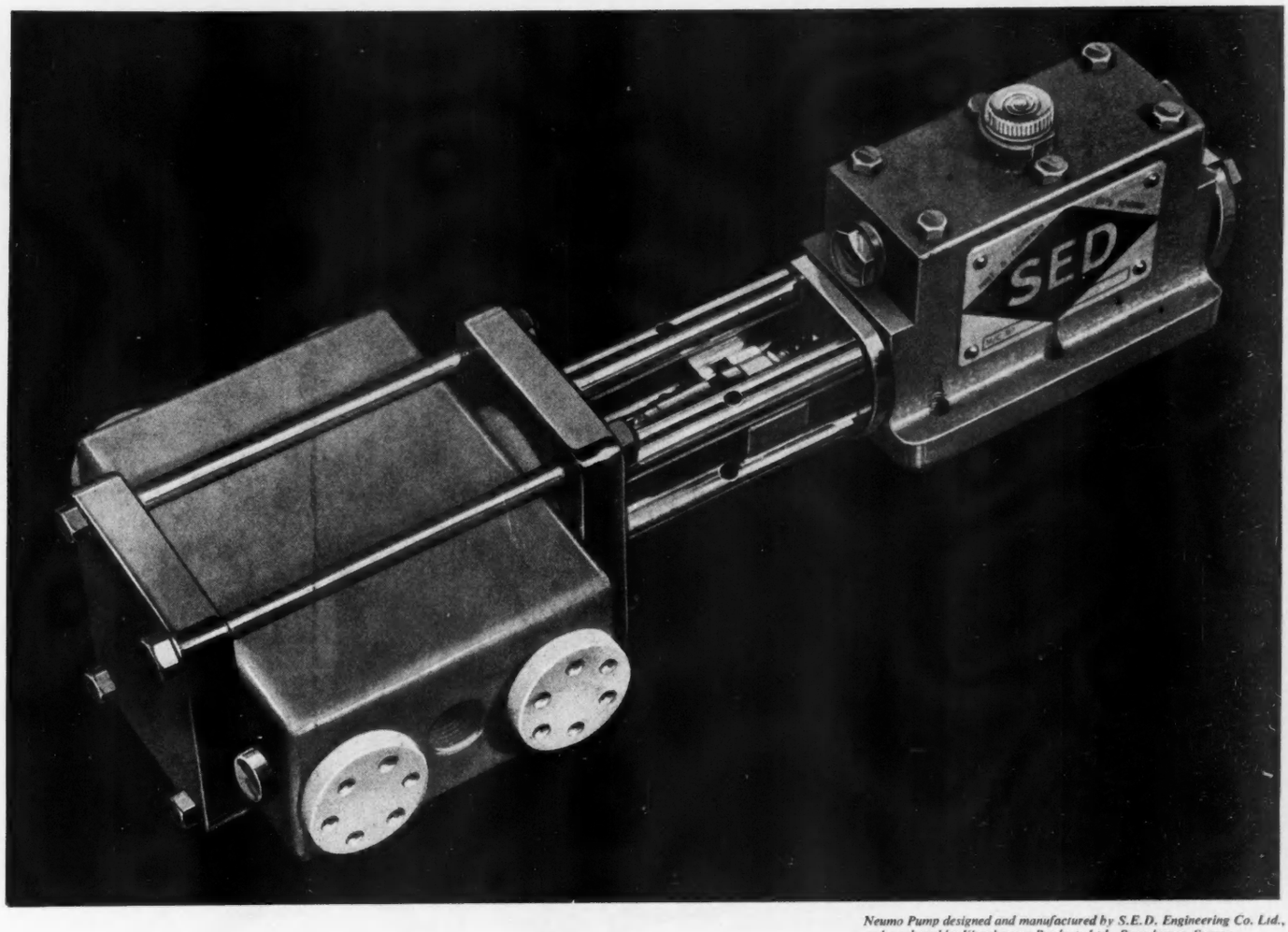

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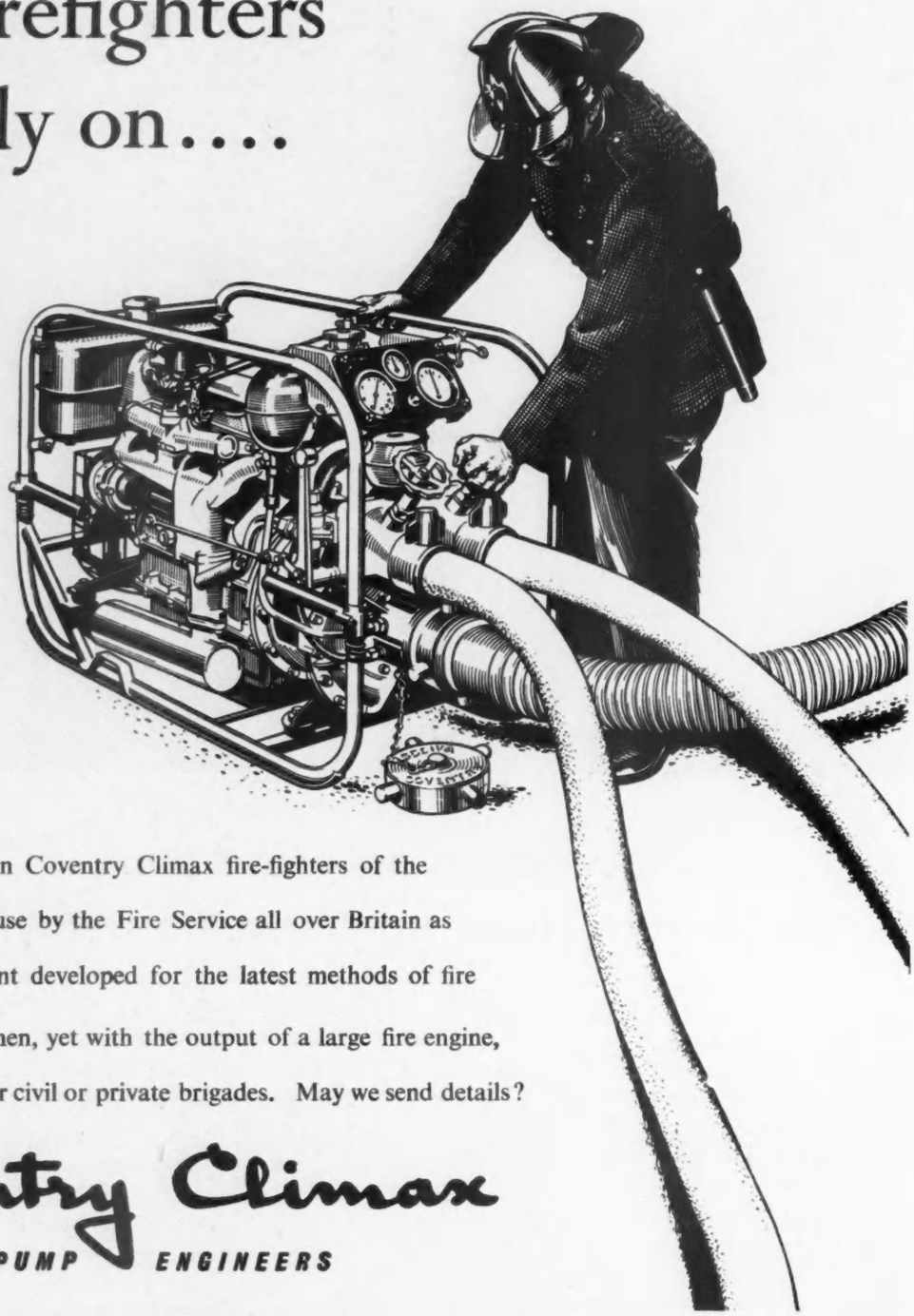

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THE ENGINEER

No. 5327 FEBRUARY 28, 1958 VOL. 205

LORD COHEN'S COUNCIL

If the Cohen Council on Prices, Productivity and Incomes was set up with the idea that a non-political group of three people ought to be able to recommend an economic policy acceptable to the nation as a whole and subject, therefore, only in detail to party political controversy, that concept has already proved a failure. For though, for our part, we regard the report of the Council as valuable and its conclusions in general sound, that is only because those conclusions happen to agree very closely with our own assessment of the situation and that of such bodies as the British Employers' Confederation, the Engineering Industries Association, &c., which have already commented favourably upon it. But it is already obvious that the trade union reaction is much less favourable and the Labour party seems likely to regard the report of the Council almost in the light of a party political document, since in almost every way it vindicates the actions taken by the Conservative Government and rejects other proposals. Of the idea, for example, that the Government should discriminate between private investment for essential and inessential purposes it remarks that " there are many pitfalls in the way of attempting to distinguish " between them. Greater still in the Council's view " are the practical objections to the reintroduction of physical controls over investment through the allocation of machinery or raw materials." It is " not disposed to take a tragic view of the check to investment involved by present plans." It rejects the idea that a threatened recession in world trade demands an immediate change of Governmental policy though " the closest watch should be kept on the development of the world trade situation." The possibility of maintaining a slow controlled inflation is carefully examined ; but the conclusion is reached that " alike on internal and external grounds our objective should be to stop inflation, not merely to moderate its course." The cause of inflation is traced very largely to wage advances " secured by workpeople organised in powerful trade unions and using . . . arguments based on preceding movements of the cost of living." The report adds : " Whatever its initiating cause, the habit of demanding large and frequent increases in monetary rewards grows by what it feeds on, and may be found to persist after any technical justification for it in the state of the labour market has passed away." That statement, like others in the report, is one which may well be true. Yet, we wonder, is it the kind of statement Lord Cohen's Council was expected to make ? For the value of the Council—its only possible value since there are numerous politicians and economists willing to express with vigour the arguments for party views—can lie only in a reputation for impartiality. Yet the statement is of a kind which, flung across the floor of the House in an economic debate, might well inflame the Socialist Opposition !

Scarcely any of the conclusions of the Council can be palatable to Socialists and trade union leaders. A particular one is likely to prove unpalatable to individual unions. It is that if inflation is to be ended, then within industries in which productivity is rising at more than the average rate the benefit should be reflected as much in the falling of price of the product—thus benefiting the whole nation—as in the wage packets of men working in that industry. For, it is argued, if the whole increase of productivity is reflected in the wage packet then men in other industries whose productivity is rising less fast will demand equivalently increased rates and inflation must necessarily follow. The argument is sound enough. But the trouble with economics is that it is not a science. Any economic calculation involves the assessment of an imponderable ; and that imponderable is the reaction of individual human beings to the economic consequences of any action taken. Victorian economic orthodoxy, for example, assumed that it was as easy to vary wage rates as to vary prices. In fact, of course, though there is never any objection from workpeople to an increase in wages it has become almost impossible to lower them. Unemployment is regarded as a preferable alternative. Nowadays human reaction has gone even further. Not only must wage rates never fall, actually or in real terms, but " full employment," is demanded. It is certainly possible that the community as a whole might prefer the evils of a creeping inflation, which (at least at first) harms only those few ill-organised to resist politically, to the evil of unemployment for a small fraction of the labour force even though combined with a stable price level for the remainder. Nor, though some trade union leaders might agree that the granting of wage claims excessive in relation to increases in productivity yields no real benefits to the workpeople, does it necessarily follow that such claims ought never to be made. For we have here the old question as to which came first, the chicken or the egg. Does rising productivity stimulate wage claims ; or do wage claims stimulate managements to find improved methods of production ? There is undoubtedly something to be said for the latter point of view provided wage claims are not excessive.

It follows from the intimate relation between economic theories and human reactions to them that it is not possible to state positively that one economic policy is the right one to pursue and that other policies are undoubtedly wrong. Upon examining what appear to be the inevitable consequences of pursuing differing policies any man can regard one of those policies as preferable to the rest ; and anyone making the choice, being human, is rather likely to assume that what seems preferable to him must also be best for the community as a whole. It is, therefore, because there may be this political context in any economic discussion—this element of choice—that we must express some discontent with the Cohen report. For under its terms of reference there was no need for the Council to recommend any particular action as better than another or to conclude that it

would be preferable to pursue any particular policy. For necessarily, when it does so, it descends into the political arena; whereas its purpose should have been to look down upon the arena from Olympian heights. The Council has been appointed "to keep under review changes in prices, productivity and the level of incomes." Under such terms of reference its job, surely, is intended to be that of presenting, as impartially as men can do so, the facts of past and present history and in looking to the future, to present as impartially as possible the consequences of taking any one of several possible economic actions, without expressing preference. For to express a preference is to become political. In our view, the Council could have made a more significant contribution to public understanding of the issues involved if it had "summed up" the evidence rather than, as in many parts of its report it does, pronounce judgment upon it.

ADMINISTRATION OF THE ROYAL DOCKYARDS

In a recent leading article in this journal, we gave an outline of the reorganisation of the production departments of the Admiralty. Sir Barclay Nihill's committee whose recommendations formed the basis for the reorganisation has also been investigating the administrative organisation of the Royal Dockyards. This section of the committee's report has now been completed and as the First Lord announced in his statement accompanying the Navy Estimates, the Admiralty has again accepted its recommendations. It has been decided to replace the traditional structure based on three professional departments working directly under the Admiral Superintendent and each having a considerable degree of autonomy in technical matters. A general manager is in future to be appointed to each of the home dockyards to act under the general direction of the Admiral Superintendent and with full authority for the administration and organisation of production work in the dockyard. As a general rule, appointment to this office will be made from existing professional officers with long experience of the Royal Dockyards. Under the general manager, the present organisation of professional departments will be replaced by a functional and integrated organisation each under a manager. These departments will cover planning, production, yard services and personnel, the manager at the head of each department acting under the direction and control of the general manager, subject to the appropriate financial authority.

The Captain of the Dockyard will from now onwards be known as "Naval Assistant and Queen's Harbour Master." He will be entirely relieved of his production work, which will be undertaken by the production manager and will be responsible for the mooring and berthing of ships and for work which arises in the field of boom defence and marine salvage. Yard Service craft which will be known as the "Port Auxiliary Services," will also be under his direction, the general administration of the Port Auxiliary Services being one of the duties of the Director-General of Dockyards and Fleet Maintenance to be appointed in accordance with the Admiralty reorganisation. Finally the Admiral Superintendent will have general responsibility for the whole dockyard, for the ships that come into the dockyard and for the general discipline, both of service personnel and civilians, in the dockyard. He will also be chairman of the yard industrial and non-industrial Whitley Committees and it will be his task to see that the yard meets the requirements of the Fleet as regards work on ships. With this reorganisation of the dockyards, there is no longer any need for a deputy superintendent (industrial)—an appointment which was made at Chatham Dockyard two or three years ago as an experiment. The experiment however confirms the view that the appointment of a general manager would be a sound proposition if he were in authority over a functional form of organisation. The deputy-superintendent concerned has in fact now been appointed general manager (designate). A steady increase in efficiency and a considerably higher level of productivity should result from this reorganisation and from the introduction of systematic planning of work for the dockyards. Waiting time should be greatly reduced and there will be a more even flow of work, with all the benefits associated therewith.

TECHNICALITIES AND BUS ECONOMICS

A paper read by the director of research of the London Transport Executive, Mr. A. T. Wilford, to the economics and operations group of the Institute of Petroleum this month was entitled "The Fuel Economics of Public Road Transport." The importance of the subject is made clear on the first page, where it appears that this year London Transport will pay £2,000,000 for fuel oil, upon which it will pay £4,000,000 in fuel tax. Over 13 per cent of total working expenses is represented by fuel costs. The most fruitful approach to improved fuel efficiency has, apparently, been the use of lower viscosity engine oils, and this is a procedure that should have a wide application, since it will be even more valuable to operators whose vehicles burn much of their fuel cruising at light load rather than accelerating hard. It is obviously undesirable to select the engine oil purely to meet some rarely-occurring case of overload or long-sustained full load; but now that molybdenum disulphide, for instance, is available in stable forms such as colloidal solutions, it will, no doubt, become the practice to select the oil to provide the heat dissipation needed in steady running, and allow the boundary lubricant to safeguard the engine against any occasional oil film failure.

But more might be done, as is emphasised strikingly by the well-supported observation that fuel efficiency improves with increasing ambient temperature. This seeming contradiction of thermo-dynamic principles stems from the fact that operating conditions within the engine do not at all closely comply with the ideal. The fuel flow, for example, does not alter with air mass flow: and the coolant entry temperature is not regulated by the desired rate of heat flow from the engine. As for the oil temperature, it is so far out of control that we read: "The observed increase in consumption during tests carried out when rain is falling is no doubt due to splashing of water on to the bottom of the engine crankcase, thereby cooling the lubricating oil and so leading to a temporary increase in engine friction losses." Such an anomaly need not be tolerated—an American oil engine now being built in Scotland, for example, has a fuel system incorporating temperature compensation. Lubricant viscosity indicators have been seen for long on United States diesels, so that there is no essential reason why the temperature of the oil should be left exposed to the whims of chance. But London Transport cannot expect the vehicle builders, even if given a free hand, to make suitable modifications. For the improvements of fuel consumption sought are in the second place of decimals, and can be observed reliably only by a fleet owner. Yet we may also wonder why the text-book method of improving engine efficiency, compounding the piston engine

with a turbo-compressor, has, apparently, been left to municipalities in the North and Midlands. Is it, perhaps, because higher maintenance costs are believed to outweigh fuel savings ? There is also the loss of 5 per cent of fuel incurred in the fluid coupling, which costs roughly £40 per year per bus : transmissions exist in which hydro-kinetic drive is used only at road speeds near zero, and it is not irrelevant to inquire why the transmission of the 1930s is still in use. Are more modern drives so much less reliable, so much less simple to operate, or so much more costly to maintain that a loss of £40 per bus per year must be tolerated ?

But if Mr. Wilford's paper stimulates the reader to ask critical questions about vehicle design it also arouses criticism of the prevailing taxation policies of Great Britain. The present tax on fuel for road and air vehicles is levied on a volumetric basis. Thus, the offer of fuel blended from the " comparative abundance of lighter distillates " will not be welcomed by operators, as the tax per B.Th.U. would rise. Certainly the artificial price structure of fuels has rendered the development of new engines and the design of new refineries unnecessarily speculative. For such tasks take years to come to fruition, while alterations of fiscal policy undermining the calculations on which they are based may be made almost at any time ! But to be critical is one thing ; to devise a less defective system of taxation is another. Perhaps the major criticism should be directed less at the system than at the weight of the taxation. For whatever kind of taxation is devised it is likely to have repercussions on the calculations of designers and the economics of operation and to arouse complaints of inequitability. The lower the level of the tax the less serious are the complaints aroused.

INDUSTRIAL RELATIONS

Last Monday, the House of Commons debated an Opposition motion which expressed " concern at recent increases in local unemployment." A Government amendment, whilst recognising this concern, welcomed the Government's intention " to continue the practical steps being taken to deal with pockets of unemployment in particular localities." During his speech moving this amendment, the Minister of Labour, Mr. Macleod, emphasised that the problems affecting men and women in a factory ought to be studied just as carefully as the problems which affected raw materials and technical processes. Many firms, the Minister said, had excellent redundancy policies, but those policies could be effective only if from the very beginning the trade unions were taken into full co-operation. Only through confidence could the right sort of relationship be built. That, Mr. Macleod added, was why he had issued to industry examples of good employment policies which could do a great deal to ensure the success of our industrial effort.

The Minister's reference, it should be explained, was to a booklet entitled *Positive Employment Policies*, which has been sent recently to 15,000 employers in Great Britain. It cites some examples of management practices which, in the Minister's considered opinion, are contributing to good relations in industry. The hope is that by studying the details of these policies industry generally will be inspired to take a fresh look at the all important matter of " human relations." The booklet emphasises that, from the management's point of view, an employment policy is an integral part of the whole managerial and production policy of a firm. The objective, it is remarked, must be the creation of a co-operative, responsible and efficient working force. To this remark there is added a gentle reminder that " regard must be paid to existing agreements and established practices in the industry and to the essential role of the trade union." From the employees' angle, the booklet says, the policy must provide not only fair conditions of employment, but satisfaction on the job, opportunities for advancement and reasonable security. The Minister himself sums it up quite neatly in a foreword to the booklet by commenting that industrial efficiency has always depended as much upon human factors as upon mechanical and technical resources ; productivity and adaptability demand the active co-operation of employees at all levels. This co-operation is best achieved, the Minister believes, where workers understand the aims and plans of management and are confident that their interests are being safeguarded. These are sentiments that already command a large measure of agreement throughout industry. Despite the large number of working days lost annually in this country on account of disagreements, industrial relations are, for the most part, better than they used to be. A few weeks ago " Industrial Relations " was the subject of a debate in the House of Commons. On that occasion there were some opposition speakers who seemed to think that the situation was deteriorating, and that for such a situation the Government must be blamed. The charge can be answered, as was pointed out by the Parliamentary Secretary to the Ministry of Labour, by the fact that in the last four months of 1957, following the introduction of the latest economic measures, there were fewer days lost in strikes than in the comparable period of any year since 1951. That debate, like last Monday's, brought out at least one fact that is well known, if not always fully appreciated. It is that the maintenance of good industrial relations is the joint responsibility of employers and employed. It is a fact that needs to be kept in mind just as much by the unions as by the employers' associations.

The Engineer — 100 Years Ago (FEBRUARY 26, 1858)

" LIVERPOOL POLYTECHNIC SOCIETY "

" The usual meeting of this society was held on Monday evening, in the Royal Institution, Mr. Maxwell Scott in the chair. Mr. O'Neile exhibited and explained a model of an apparatus for communicating betwixt the guard and passengers and the engine driver on railway trains. It consisted of an iron bar, running longitudinally under each carriage, between the bottom of the carriage and the axle-tree, and moving freely upon a pin in the centre. One end was made somewhat heavier than the other, and rested in a hanging latch attached to the end of the carriage. By pulling a string inside of the carriage this latch was raised, and the heavy end of the bar thus liberated, the other end flew up, striking in its ascent a projecting angle of the next latch, liberating another bar, and so on to the end of the train, the last bar setting off an alarum attached to the engine or tender. The position of the bars afterwards would show the exact carriage from which the alarm had been given, and the apparatus could be set again by the guard as fast as he could walk along the train.

" Mr. Brown considered the invention an excellent one, and very simple, as all good things were ; but he thought that many people would give an alarm unnecessarily, if it were generally applied. Mr. Salt said the same objection would apply to all inventions of the kind. The Chairman suggested that the string might be secured by a seal, or something of that kind, which would have to be broken before it could be used. Mr. Salt asked what the probable cost of the apparatus would be. Mr. O'Neile said it might be fitted for about £2 each carriage."

Boulton and Watt and the Mechanisation of the Brewing Industry

By A. K. BRUCE, M.I.Mech.E., M.A.S.M.E.

This bronze group on a stone pedestal was recently unveiled in Birmingham as a memorial to Matthew Boulton, James Watt and William Murdoch

IT is recorded that in 1760 there were in London fifty-two principal brewhouses, the quantity of beer brewed by them in one year being 975,217 barrels. In Johnstone's *London Commercial Guide and Street Directory* for August, 1817, as many as ninety-four breweries are listed, a distinction being made between brewers of porter and brewers of ale and table beer. Prior to the introduction—towards the end of the eighteenth century—of the rotative steam engine, the power required by breweries was supplied (in the absence of water-wheel power) by horses, and if we look at plans showing the lay-out of breweries in the pre-steam-engine era, it will be noted that a substantial fraction of the floor space was occupied by stables. All road transport was, of course, horse-drawn and horses harnessed to water-wheels were used for grinding the malt, pumping the liquor and other purposes. While the number of horses per wheel varied records show that to turn an average brewery horse-wheel six horses were required per shift, it being estimated that the cost of maintaining and feeding each horse amounted to about £40 per annum. Considering the number of breweries which, existing in London during the last quarter of the eighteenth century, depended upon horses as their source of motive power, it is not surprising that the steam engine should have made a strong appeal to brewers and that the success of the first rotative steam engine installed in a brewery was to prove an extremely influential episode in the early history of the Boulton and Watt engine.

In his account—published in 1865—of the introduction of the rotative steam engine, Samuel Smiles (*Lives of Boulton and Watt*, page 327) states that " The first engine of the kind erected in London was at Goodwyn & Co.'s brewery; and the second, still working, though in an altered form, at the Messrs. Whitbreads. These were shortly followed by other engines of the same description, until there was scarcely a brewery in London that was not supplied with one." In a footnote on page 335, Smiles goes on to relate how " The parallel motion was first put in practice in the engine erected for Mr. Whitbread, Watt informing Boulton (October 27, 1785) that 'the parallel motion of Whitbreads answers admirably.'" The issue becomes confused on page 353, where Smiles describes the engine for the Albion Mills, Southwark, as " the first rotative with a parallel motion erected in London." Actually, the first of the Albion Mill engines was not started up until early in 1786. It is to be remembered, moreover, that during 1782 Watt—strongly pressed by Boulton—was busy with development work on the rotative engine. Writing to Boulton in October, 1782, he states that " These rotatives have taken up all my time and attention for months, so that I can scarcely say that I have done anything which can be called business."

Before the end of 1782 Watt had, however, tested some of his schemes on an existing engine at Soho, with which he operated a tilt-hammer and a corn-mill. " There is now no doubt (he writes to Boulton) that fire-engines will drive mills " and the first rotative engine built by Boulton and Watt to a customer's order appears to have been started up on April 27, 1783, at the Bradley (Shropshire) Ironworks of John Wilkinson, where it was used for working a tilt-hammer. Long afterwards, when writing (September, 1809) his memoir on Matthew Boulton, Watt remarks as follows:

" I think it was in 1782 that I obtained a patent for the rotative engines which with their subsequent improvements have been of so much service to the manufactures of this country. The first in London was erected for Messrs. Goodwyn & Co., Brewers, which was followed by Mr. Whitbread and others."

This passage in the memoir makes it clear that the engines supplied first to Goodwyn and Co. and then to Mr. Whitbread were indeed the earliest of Watt's rotative engines erected in London. Following them came, among others, the much-publicised engines for the Albion Mills, Southwark, the first of which appears to have been started on February 15, 1786, though Dickinson states that " it was some weeks later before it worked under load." While there can be no doubt about the sites on which were erected the first two rotative engines installed by Boulton and Watt in the London area, it is equally clear that these particular engines were single-acting and that at all events the first of them was not fitted, at the outset, with the parallel motion. Watt's patent (No. 1432) for the parallel motion was applied for on April 28, 1784, the specification being enrolled on August 25, and Watt has related how " the invention was made in the latter end of 1783 " (*Appendix to Robison on Steam and Steam-Engines*). It was not until June 30, 1784, that Watt, in a letter to Boulton, states that he has " Started a new hare. I have got a glimpse of a method of causing a piston-rod to move up and down perpendicularly, by only fixing it to a piece of iron upon the beam without chains, or perpendicular guides, or untowardly friction, arch-heads, or other pieces of clumsiness . . . I have only tried it in a slight model yet, so cannot build upon it, though I think it a very probable thing to succeed, and one of the most ingenious simple pieces of mechanism I have contrived, but I beg nothing may be said on it till I specify." Nearly four months later (on October 21, 1784) he writes that " The new central perpendicular motion answers beyond expectation, and does not make the shadow of a noise." Consideration of these statements by Watt make it clear that the parallel motion cannot have been fitted on Goodwyn's engine when it was first put to work in East Smithfield. Smiles does not mention having examined the details given in the Boulton and Watt *Engine Book*, from which it can certainly be inferred that the engine built for Goodwyn's was not so fitted, the entry relating to this particular contract being marked: "(Chain Beam) " with the sign " ? " above each of the two words. Moreover, this engine is stated to have been changed to double-acting in 1788, when the parallel motion would be fitted. From Boulton and Watt's *Engine Book* (sheets relating to engines with sun and planet gear supplied to customers in the County of Middlesex) we learn that the formal contract was entered into with " Hy Goodwyn, St. Botolph Aldgate, Brewery in the parish of Saint Botolph, Aldgate," the cylinder size being 15in by 4ft 0in, the book entry stating that the cylinder bore was increased to 16in in 1788. Instructions to put the engine in hand were issued by Henry Goodwyn (after consultation with his partners) on April 17, 1784, it being on record that earlier in the year he had made a visit of inspection to Birmingham. The customer strongly urged the need for quick delivery and it appears that Boulton and Watt made every effort to expedite completion, since the engine was erected and ready for work in August, 1784.

The earliest date on the drawings relating to this engine is May, 1784, it being of interest to note that at about the time they made their contract with Henry Goodwyn, Boulton and Watt also contracted with Henry Coates and John Jarratt of Kingston-upon-Hull (Sculcotes Oil Mill) for the supply of an engine 15in by 4ft 0in, 7 h.p., 25 strokes. Since May, 1784, is again the earliest date on the drawings, it is reasonable to assume that the Goodwyn engine and the engine for Coates and Jarratt, being of the same size and date and fitted with sun and planet gear, would be made from the same drawings. Also to be noted is the fact that on the Soho *Engine Book* record relating to the engine for Coates and Jarratt there are the following annotations:

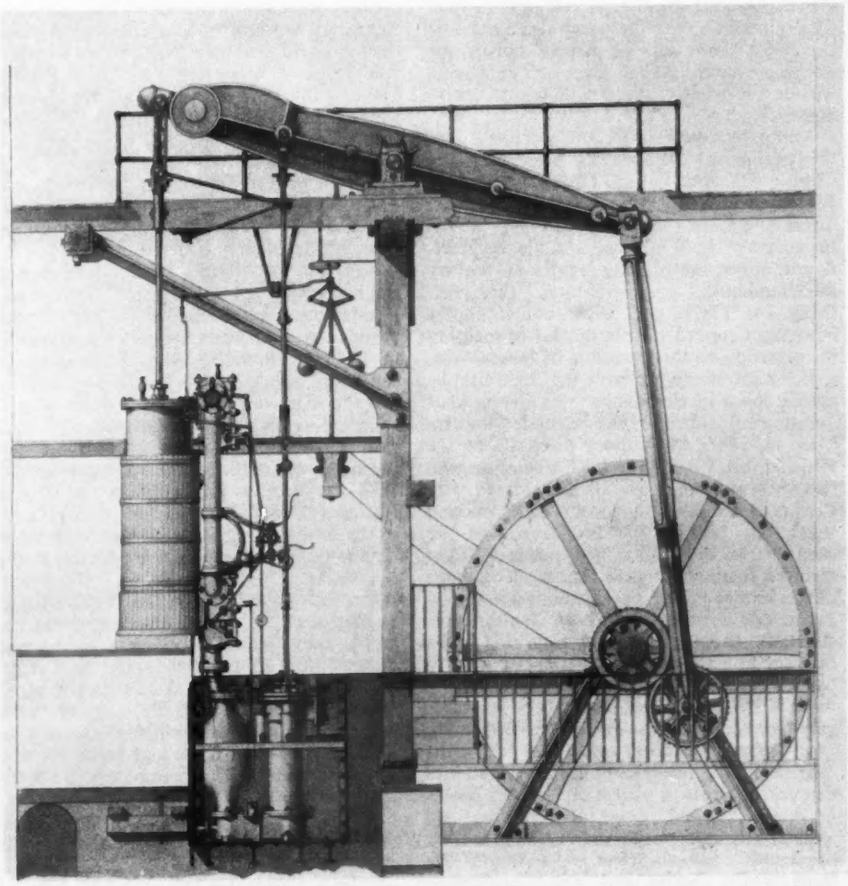
" Rack on piston rod. " " One of the Soho Tilt engine cylinder(s) used. "

Consideration of these particulars suggests that at the time the engines for Goodwyn (Red Lion brewery), Whitbread (Chiswell Street brewery) and Coates and Jarratt (Scul-

cotes) were ordered, Watt was still engaged in testing alternative methods for connecting the piston-rod to the beam. (See details in patent No. 1432.) We know that at least four of the rotative engines (sun and planet gear) supplied to John Wilkinson for his Old Furnace Forge, Bradley, Staffordshire, had the " chain-on-beam " connection, the earliest date on the drawings of the first of these engines being July, 1782. One of the engines thus equipped had a cylinder 42in by 6ft 0in, the sun and planet wheels being 48in and 24in diameter respectively. The rotative engines supplied in 1784 to Richard Reynolds and Co., of Horse Hays Forge, Shropshire, were also fitted with beam chains, the date on the earliest drawings being May, 1784. These Horse Hays Forge engines (or at least one of them) were 26in by 6ft 0in. We read also of a Watt sun and planet engine 22in by 4ft 0in which, supplied to Josiah Wedgwood in 1784, had " single link on piston rod." Whatever may have been the exact details of the connection between the piston-rod and the beam, the engine at Goodwyn's brewery appears to have given satisfactory operation from the outset and we know that Watt was very pleased with it. Smiles quotes a letter in which Watt states how the engine " performed wonderful well—not the smallest leak and scarce any noise. . . . The working gear and joints are the best I ever saw."

The site upon which was erected the first rotative steam engine supplied by Boulton and Watt to a customer in London is clearly shown on Horwood's plan of London dated May 24, 1799. From this plan it will be seen that " Goodwyn, Skinner and Thornton's Brewhouse " stood in Lower East Smithfield, within the angle formed by the thoroughfares marked " Burr Street " and " St. Catherines." In *Holden's Directory* for 1802–1804 (third edition) the title is again " Goodwyn, Skinner and Thornton " and the address Lower East Smithfield. In the edition (the third) of *Horwood's Plan* published by W. Faden during 1813 the site is marked " Red Lion Brewery," and we read that there was a brewhouse here as far back as the early part of the sixteenth century. The brewing industry persisted at this site until shortly before 1939, when the demolition of the Red Lion brewery made way for the erection of the blocks of London County Council flats (Stephen and Matilda House) which now stand in the angle formed by Thomas More Street and St. Katharine's Way, Stepney.

References to the brewery are found in early issues of *Kent's Directory* and the *Post Office London Directory*, under the names " Goodwin and Co." and " Henry Goodwyn and Co.," the address being 21, Lower East Smithfield. In the *Post Office London Directory* for 1825, however, the name Goodwyn is not mentioned and there appears the name and address " Hoare and Co., Brewers, 21, Lower East Smithfield." In *Kent's London Directory* for 1826 the entry " Goodwin and Co., brewers, 25, Lower East Smithfield " is found along with an entry " Hoare and Co., brewers, 20, Lower East Smithfield." Thereafter, the directories do not appear to contain any further mention of the name Goodwyn (or Goodwin). Hoare and Co. continued at the Red Lion brewery until the business was acquired by Charrington and Co. in or about 1918. The present writer has not been able to obtain any information as to the history of the Boulton and Watt engine at Red Lion brewery after its setting to work and it would indeed be interesting to know just what became of a machine which, had it survived, must have formed a notable addition to British technological relics.



Engine by Messrs. Boulton and Watt of Soho, Birmingham, " erected for Messrs. Whitbread and Co. 1785, as of 35 horsepower. Altered in 1795 and increased in power. Removed 1887."

While the first Boulton and Watt rotative engine delivered to the London area was certainly the 15in by 4ft 0in engine supplied to the order of Messrs. Goodwyn, Skinner and Thornton and installed at their Red Lion brewery in Lower East Smithfield, this installation was very quickly followed by another of considerably larger size ordered for Whitbread's brewery, Chiswell Street. The date of the formal contract was July 1, 1784, the actual indenture—or " parchment " —being preserved in the Boulton and Watt Collection at the Birmingham Public Library. The *Engine Book* entry shows the original cylinder size to have been 24in by 6ft 0in and the date on the earliest drawing June, 1784. The customer was:

" Samuel Whitbread of the Parish of Saint Luke, Brewery situated in Chiswell Street, in the Parish of Saint Luke (Chain Beam) Payment £63 annually by half yearly payments. Made 25″ in March 1814."

The words " Chain Beam " in the above entry (as in the entry relating to the engine for Goodwyn) appear to indicate that at the outset the use of the parallel motion had not been contemplated. As for the sentence: " Made 25″ in March 1814 " this must refer to a change in the bore of the cylinder. The *Engine Book* entry also contains (between brackets) the words: *Safety Valv.* It has been mentioned above that the engine for Red Lion brewery was ordered by Henry Goodwyn on April 17, 1784, and we read that on May 25 of the same year Jacob Yallowley, one of Samuel Whitbread's senior clerks, wrote to James Watt as follows:

" Sir,

I wrote to you 22nd. INST. since which we are informed by Mr. Goodwyn that he saw two engines at work at your house at B'ham. Mr. Whitbread requests the favour of you to say by a line pr. Posts return whether or not they are still up, and in use, if they are one of us will come and see them immediately.

I am Sir,

Your most humble servt.

J. Yallowley."

No time was lost in examining the engine and in obtaining information as to the estimated consumption of fuel when performing an amount of work equal to that accomplished by ten horses. In naming ten horses, the cautious customer was providing a large margin in power, since we are told that the Chiswell Street horse-wheel could be turned at the required speed by the efforts of six horses. Since it is on record that the engine for Whitbread's brewery was delivered during the summer of 1785, also, that on October 27 of the same year Watt wrote to Boulton informing him that " the parallel motion of Whitbread's answers admirably," it may be assumed that the cylinder casting was probably ready at Wilkinson's foundry before the formal order was placed and it seems likely that an informal instruction to put the work in hand may have been given before the date of the " parchment " order.

This engine having been erected prior to the setting up, in 1795, of Boulton and Watt's Soho foundry, the parts (including the cylinder cast and machined by Wilkinson) would be collected from various manufacturers, assembled at Chiswell Street and erected there to drawings and instructions provided by Watt, though certain items (including, doubtless, the components for the sun and planet gear and for the parallel motion) may likely have been supplied from Boulton's Soho manufactory. To those who have had experience of the inordinate delay which can take place in the execution of engine orders, it may be matter for surprise

that within ten years from the date of delivery of the first engine built by them to a customer's order, Boulton and Watt were able not only to quote quick deliveries but to keep faith with their promises. It is true, of course, that apart from a cylinder, nozzles, valves, pipework and other metal components normally assembled at the site, the engine consisted of a timber framework with rocking beam, &c., the engine-house walls being virtually part of the engine structure. We know that particular care was taken in the preparation of the site for the Chiswell Street engine, preparations supervised by John Rennie who dealt with the millwrighting and to whose control of the arrangements may likely be attributed the smoothness with which the change-over from horses to steam appears to have been effected. We read that the toothed wheel on the engine shaft was over 9ft in diameter and meshed with teeth on a horse-wheel 21ft 6in diameter this horse-wheel being driven at a speed of 4½ r.p.m. in order to operate the malt grinding stones at the correct milling speed of 98 r.p.m.

Considerable alterations were made on the engine in 1795 when it was converted from single-acting to double-acting, this involving a partial reconstruction. There had, moreover, been some severe breakages on another engine, breakages which must have greatly disturbed Watt, since in a letter addressed to Boulton on March 22, 1786, he includes the following significant sentence: "As far as human foresight can extend we should not expose ourselves to such accidents if can be prevented." This and other experiences doubtless accounted for the replacement, on Whitbread's engine, of the original wooden beam by a cast-iron beam 20ft long and the fitting of an iron connecting-rod 18ft long. At the same time a diagonal cast-iron strut was added to stiffen the wooden framing, the original segmental cast-iron flywheel (16ft in diameter) being retained. The drawing reproduced herewith shows the engine as thus reconstructed in 1795 and it is probable that the parts required for the reconstruction would be among the early deliveries from the then newly-inaugurated Soho foundry. It will be noted that the accessories include a centrifugal governor. This could not have been fitted at the outset, since it was not until late in 1788 that the centrifugal governor was first used on a Boulton and Watt engine, this being the so-called " Lap " engine now preserved at the Science Museum, Kensington. A further modification on Whitbread's engine was made in March, 1814, when the cylinder bore was increased from 24in to 25in. According to some notes made by Mr. Owen Blacket and printed in the *Australian Technical Journal of Science, Art and Technology*, Vol. 1, No. 1, February 27, 1897, the teeth on the " sun " wheel of the sun and planet motion gave way several times as they were of wood; " these were replaced by brass teeth which are now in the wheel and stood their work very well, when the engine has been worked of late years as a ' stand-by ' engine when the other engine in the brewery required repair. It will be noticed that the valve motion is distinctly a ' tappet ' motion, with catches that are let off, for opening some valves, by the very small portion of the stroke of the engine, there being a small set-screw which is so set as just to detach the latch at the end of the stroke. The balance-weights to the valves work in pots of water, having a hole in the side of the pot, just softening the blow, or acting to some extent as ' cataracts.' There are no eccentrics to the engine, though all the later Boulton and Watt engines had them. The cylinder is not steam-jacketted like more modern Boulton and Watt engines, but is well lagged with wood."

On the performance of this engine there is reproduced in a history of the Brewery published during 1951 by Whitbread and Co., Ltd., the text of a letter written, at the time the engine was installed, by Joseph Delafield, one of the brewers at Chiswell Street:

" Last summer we set up a steam engine for the purpose of grinding our malt, and we also raise our liquor with it. It is built in the place where the millhouses used to stand with the malt loft over them . . .

" Our wheel, you may remember, required six horses to turn it, but we ordered our engine the power of ten, and the work it does we think is equal to fourteen horses, for we grind with all our four mills about 40 qrs. an hour, besides raising the liquor. We began this season's work with it, and have now ground about 28,000 qrs. without accident or interruption. Its great uses and advantages give us all great satisfaction and are daily pointed out afresh to us.

" We put aside now by it full 24 horses, which to keep up and feed did not cost less per annum than £40 a head. The expense of erection was about £1000. It consumes only a bushel of coals an hour."

It is interesting to note Delafield's statement as to the number of horses " put aside " by the Watt steam engine. Muirhead, commenting with regard to the evolution of methods of computing engine output on the basis of horsepower, remarks how Savery, writing in 1702, shows that an engine is capable of doing the work not only of as many horses as could at any one time produce an equal effect, but of as many as would have to be kept in order to produce the same effect constantly. " So that an engine," says he, " which will raise as much water as two horses, working together at one time in such a work, can do, and for which there must be constantly kept ten or twelve horses for doing the same, then I say, such an engine will do the work or labour of ten or twelve horses."

About two years after the starting-up of the engine at Whitbread's brewery, King George III and Queen Charlotte, accompanied by three Princesses, visited Chiswell Street and were received at the door of the brewery by Mr. Whitbread and his daughter. A plaque on the existing eighteenth-century dwelling-house commemorates the visit (May 24, 1787), and while contemporary newspaper reports do not appear to mention the presence, on this occasion, of James Watt, it seems extremely probable that he would be among those in attendance. As a somewhat amusing coincidence it can be related how on May 16, 1787, when those delegates to the Philadelphia Constitutional Convention who had then arrived at Philadelphia dined with Benjamin Franklin (then in his eighty-second year), the philosopher broached, for the occasion, a cask of porter which he had received from an English friend. The name of the brewer of this porter is not mentioned but it could easily have been Whitbread's, statistics showing how during 1787 the brewery in Chiswell Street produced 150,280 barrels of porter, this being the largest output reached by any of the London brewers. We may therefore smile (as Franklin would surely have smiled) at the thought that just eight days before the delegates to the Constitutional Convention were to pledge each others health in English-brewed porter, King George III had paid a ceremonial visit to Whitbread's brewery in Chiswell Street and examined the Watt steam engine and other equipment installed there. We know, moreover, that the subject of steam engines was referred to in some detail by George III—who had a remarkable memory—during his conversation with Watt at Windsor in June, 1790. Chiswell Street must surely have been familiar ground to Watt who, as has been mentioned above, was in close touch with the final adjustments on the engine when put to work in 1785. He had also been consulted by Mr. Whitbread on other matters connected with brewery mechanisation.

It remains to be related how, shortly before the Chiswell Street engine was removed—in 1887—to make room for a more powerful and more economical unit, the late Mr. T. H. Houghton, M.I.C.E., M.I.E. Australia (then acting as resident engineer at Whitbread's brewery) saw it in operation under steam. Not so well known as it ought to be is the fact that the historic steam engine remains in existence to this day, having been presented by Whitbread and Co., Ltd., to the Government of New South Wales, Australia. The decision thus to dispose of the engine appears to have been largely due to representations made by Professor Liversidge F.R.S. (Emeritus Professor of Chemistry in the University of Sydney) and to Mr. E. A. Cowper, M.I.C.E., who had been consulting engineer to Whitbread and Co. If we would see the earliest surviving example of a Boulton and Watt rotative steam engine we must, therefore, go to the Museum of Applied Arts and Sciences at Sydney, New South Wales, where exhibited in a place of honour stands Whitbread's engine. The present writer examined the engine during January, 1956, when everything appeared to be in good condition, provision being made for setting the engine in motion by means of an electric motor.

The epoch-making rotative engines built for the Red Lion brewery and for Whitbread's brewery were followed, before the end of the eighteenth-century, by a considerable number of engines ordered by power users in London. Among them were the two large engines (34in by 8ft 0in) at Albion Mill, Southwark, which—due to a disastrous fire in 1791—had a short though influential life. A very successful installation was at the factory of John Maud " Chemist and Refiner " (subsequently Atkinson's Chemical Works), 66, Aldersgate Street, in the parish of St. Botolph, Aldersgate. This engine—ordered on July 1, 1797—was 16in by 4ft 0in, double-acting, with sun and planet gear, centrifugal governor and wooden beam and framing. The cylinder was changed in 1806, when the bore was increased to 19·25in. Included with the original installation was a built-up cast-iron flywheel 12ft 0in diameter. The site of John Maud's chemical works lies on the east side of Aldersgate Street south of the intersection with Barbican, where the engine was working until 1885. It is now preserved in the Science Museum at South Kensington. Examination of the Boulton and Watt *Engine Book* shows how popular was the 16in by 4ft 0in engine as installed in Aldersgate Street. One month before the engine for John Maud was ordered, an engine of the same cylinder size and certainly made from the same drawings was ordered for John Charrington and Co.'s brewery at Mile End in the parish of St. Dunstan, Stepney. On February 1, 1799, another engine, 16in by 4ft 0in, was ordered by Messrs. Sutton, Keen and Smith for their " blue and mustard " manufactory at Garlick Hill, London. In 1790 Boulton and Watt supplied an engine 16in by 4ft 0in to John Stephenson, St. Giles brewery, London, which establishment was acquired during 1809 by Mr. Henry Meux (see THE ENGINEER, Nov. 11, 1955, page 683). Also in 1790 an engine

19in by 4ft 0in was supplied to Richard Arkwright for a cotton mill in Nottingham. In 1792 Gideon Combrune ordered an engine 11½in by 4ft 0in for his brewery in Golden Lane, London. All these engines were of double-acting rotative type with parallel motion, sun and planet gear and centrifugal governors. They marked the emergence of the Boulton and Watt rotative steam engine as an established prime mover and confirmed the singular courage and prescience implicit in that letter addressed by Matthew Boulton to James Watt on February 24, 1776:

" Pray tell Mr. Wilkinson to get a dozen cylinders cast and bored, from 12 to 50 inches diameter, and as many condensers of suitable sizes. The latter must be sent here, as we will keep them ready fitted up, and then an engine can be turned out of hand in two or three weeks."

Also to be remembered is the sagacity of Watt as instanced in the words which he addressed to Samuel Ewer, Jr., at a time when an increase of steam pressure was being strongly urged:

" It cannot be done without rendering the machine more complicated than we wish: and simplicity is a most essential point in mechanics. There are other contrivances known to us which would increase the effect in an inferior degree . . . but they are all attended with peculiar inconveniences which forbid their use until the illiterate and obstinate people who are intrusted with the care of the engines become more intelligent and better acquainted with the machine."

If there is any one factor which may be regarded as having been most influential in the engineering history of the last quarter of the eighteenth century, it was the blending of the courage and enthusiasm of Matthew Boulton with the intuition and sagacity of James Watt. A memorial recently unveiled in Birmingham commemorates Boulton, Watt and Murdoch who are depicted in a bronze group on a stone pedestal inscribed only with their names and dates. Looking at this most impressive monument one realises with what skill and insight the sculptor has conferred on the figures visual hints which suggest their individual characteristics. It was these characteristics which entitle the three men to be regarded as the most illustrious team in engineering history. The monument is finely shown in the photograph reproduced herewith.

Acknowledgment is made of the courtesy of Whitbread and Co., Ltd., in granting permission to reproduce the photograph of the famous Boulton and Watt engine and to make extracts from certain of its publications, notably *Whitbreads Brewery*, published in 1951. For the photograph showing the monument recently erected (in Birmingham) to the memory of Boulton, Watt and Murdoch the author is indebted to Mr. J. E. Belliss, of Birmingham. Mention must also be made of the courtesy of the Director of the Science Museum, South Kensington, in making available for reference a photostat copy of the Boulton and Watt *Engine Book*.

Axial Flow Pump-Turbine in a Teaching Laboratory

By J. R. D. FRANCIS, Assoc.I.C.E.

THE fluid mechanics course in engineering departments of universities and technical colleges often includes laboratory experiments on a centrifugal pump and on a water turbine. The power and efficiency characteristic curves are usually obtained for each machine and presented in separate reports. Since the two machines are superficially rather different in detail, students often fail to realise the essential similarities of all " rotodynamic " hydraulic machinery. It would be in many respects preferable to have one machine which could be changed at will to be used either as a pump or a turbine. One small and compact machine which has proved satisfactory in this respect is the " Royston " circulator, made by Chas. P. Kinnell and Co.Ltd., of Southwark, London, S.E.1. This is a simple brass propeller mounted in a bend of a pipe and driven electrically (Fig. 1). It is made in two sizes, for 4in and 5in pipes, respectively, and was intended for circulating hot water in heating installations. A 5in size machine, which was kindly presented by Mr. J. Lindsay Kinnell, is now installed in the Hawksley Hydraulic Laboratory at Imperial College, London, in the manner shown in the diagram (Fig. 2). Water is supplied from the laboratory main system to a constant level tank, from which a bell-mouthed pipe leads to the circulator. The water then is led vertically downwards some 20ft, the tail-pipe being immersed in a sump. A valve is situated just downstream of the machine and the flow in the system is controlled by it. The machine is driven by a 2 h.p. d.c. motor and the input power is measured by an ammeter in the armature circuit : when the machine acts as a turbine, the output power is absorbed by a friction brake on a flywheel mounted on the motor

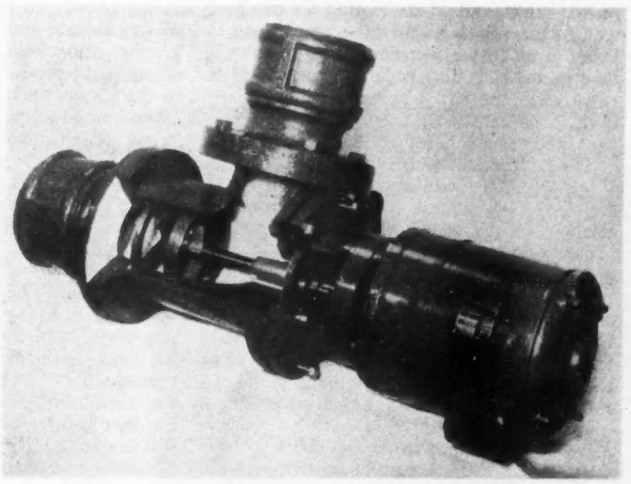


Fig. 1—The " Royston " circulator

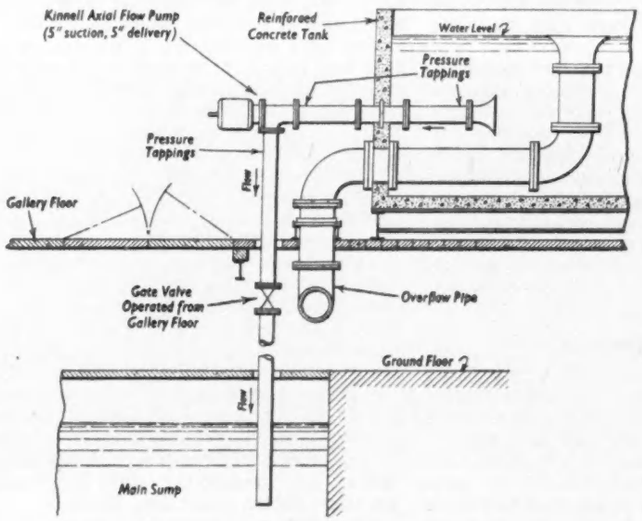


Fig. 2—Arrangement of 5in circulator

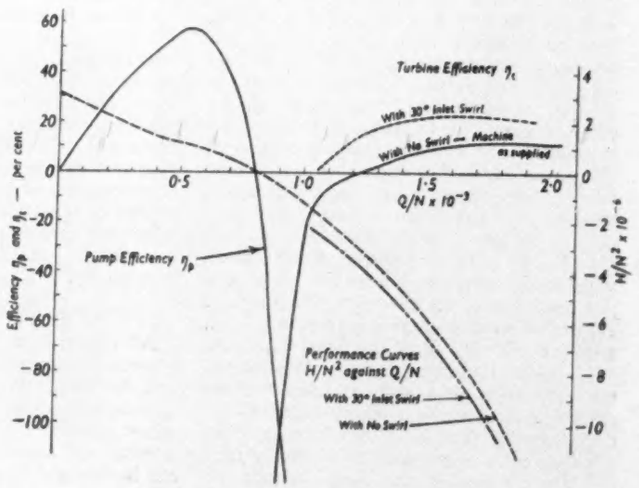


Fig. 3—Typical results

shaft. The discharge Q through the pipe is determined by measuring the water velocity head with a water manometer connected between the tank and a tapping near the bell-mouthed entry to the pipe. The pressure difference across the machine H is measured by a mercury manometer connected between tapping points at the inlet and outlet flanges.

For every opening of the valve, the machine can be made to run as a turbine at a variety of speeds by adjusting the brake, or as a pump by adjusting the electrical input to the motor. In all cases the direction of rotation and the direction of flow is the same ; the pump is pumping "down-hill," but against a partly-shut valve. For each speed N, the discharge Q, head generated H, and efficiency η are calculated, and the unit discharge Q/N and unit head H/N^2 derived. It is convenient to call H positive when the machine is acting as a pump, with the down-stream pressure higher than the upstream, and H negative when acting as a turbine.

It should also be noted that the definitions of the efficiency are different in the two cases, since as a pump η_p=water h.p. output/mechanical h.p. input, while as a turbine η_t=mechanical h.p. output/water h.p. input. When H has just reversed from positive to negative, there is insufficient power being generated by the turbine to overcome friction ; to make the machine rotate at all, mechanical power must be applied. Thus, in this range, and when treating the machine as a turbine, η_t is negative because power is being given to the machine, while treating it as a pump η_p is also negative, because H is negative ; the two efficiencies differ, however, in numerical value, one being the reciprocal of the other.

The typical results are shown in the graph (Fig. 3). The head-discharge performance curve, H/N^2 against Q/N, is continuous throughout the whole range, showing there is no sudden change in the hydraulic conditions as the machine changes from a pump to a turbine. The efficiency curve of η_t shows the customary maximum, going negative at $Q/N=0{\cdot}81\times10^{-3}$ as has just been described, and becoming minus infinity when the machine just produces enough power to rotate itself without additional mechanical power at about $Q/N=1{\cdot}23\times10^{-3}$. At this point $\eta_t=0$ so that in the zone $0{\cdot}81\times10^{-3}<Q/N<1{\cdot}23\times10^{-3}$ every observation gives rise to two efficiency points, one for η_p, the other for η_t, both negative and one being the reciprocal of the other. When η_t becomes positive and the machine develops useful work, the efficiency becomes asymptotic to $\eta_t=12$ per cent as far as the experiments were possible with the arrangement described. This maximum of only 12 per cent is low compared with the maximum of 57 per cent for η_p. The difference is attributable to the absence of stationary guide vanes at the entry of the turbine to give swirl to the water. Without guide vanes, the absolute velocity of the water on leaving the rotor has a high swirl velocity whose kinetic energy is degraded to heat by turbulence in the pipe, thus causing a low overall efficiency. In the machine at Imperial College straight guide vanes have been fitted into the entry pipe just upstream of the propeller, and they are adjustable to give swirl velocities up to an angle of 30 deg. from the axial direction. With this maximum swirl, the performance of the turbine is improved considerably, the efficiency η_t rising to a maximum of 23 per cent (see Fig. 3 again). Swirl velocities at greater angles to the axis, as normally used in large propeller turbines, cannot be satisfactorily imparted to the water unless curved guide vanes are used ; but such vanes cannot be turned so that the entry flow is truly axial when the machine is used as a pump. Moreover, the straight vanes can be turned to give swirl in the opposite direction if required.

As well as exploring the effect of inlet swirl, the basic experiment just described can be easily expanded for final year students who may occupy several laboratory periods on the one machine. It is easy to change the rotor for another with the same blade angles but with a smaller radial clearance between blade tips and the walls of the pipe, thus improving both η_p and η_t ; or to change for a rotor of which the blade surfaces have been polished, so decreasing their frictional resistance and again improving the efficiency.

The installation in Fig. 2 could be modified if the machine were to be placed in another laboratory. For example, the open tank might be dispensed with and the pump-turbine put into a closed pipe circuit, which is powered by another pump. Such an arrangement would be economical of space, since only the pump-turbine need be at floor level.

Application of Gamma Radiography to Concrete

By J. A. FORRESTER, B.Sc.*

The use of γ-radiography as a non-destructive and relatively inexpensive method of testing certain properties of cement products in the concrete and cast stone industry and in the concrete research laboratory is discussed. Radiographs showing the location and condition of steel reinforcement and the condition of concrete are described, and a technique for studying the effect of vibration on the movement of aggregate is demonstrated.

THE scope of industrial radiography has widened immensely in the past few years. This is due in part to the increased availability of inexpensive γ-ray sources, products of the atomic energy programme. Radiography is now being applied to an increasing extent in the production of metal castings and to the inspection of welds ; but, in the field of cement products, very little use has been made of this non-destructive method of testing.

Mullins and Pearson[1] have made use of X-rays for examining concrete to show variation in density and to locate reinforcing bars, but the high initial cost and immobility of X-ray equipment is a disadvantage in site examination. The successful use of a cobalt-60 source to locate reinforcing bars has been described,[2] and Fackler, in an appendix to his note on γ-ray tests on concrete[3] gives reproductions of various γ-radiographs showing the displacement of artificial aggregate in concrete after vibration.

The object of this article is to indicate the possibilities of using γ-radiography in the examination of concrete and cement products and to show how radiographs illustrate certain features of concrete. The interpretation of the cause and effect of these features is not entered into here, although the results of radiography have been used by other workers at Wexham.

It is proposed to show that honeycombing, cracking and injections of grout in concrete can be studied and that observations can be made on reinforcement to ascertain its position, condition, type and size. The movement of aggregate under vibration has been observed in a superficial way to outline a procedure which can be followed for studies on vibrational effects. Illustrations of these phenomena, and of the apparatus used, are grouped on the two art plates accompanying this article.

Principles of Gamma Radiography

All materials will attenuate γ-rays by an amount almost proportional to their density and thickness. When radiation of intensity I_0 passes through a thickness t of material whose coefficient of absorption is u, then the intensity of transmitted radiation I (which can be detected by its action on photographic film) is shown by the relation $I=I_0e^{-ut}$. The absorption coefficient is a characteristic property of an element arising from two principal interactions of γ-rays with its atoms. In one form of interaction the rays give up all their energy to an orbital electron which is expelled. This is called the photo-electric effect. The other form of interaction, called the Compton scattering effect, occurs when the γ-ray photons impinge on the peripheral electrons of the atom and undergo energy losses in becoming transformed to photons of greater wavelength. These latter photons are scattered at an angle to the path of the original γ-rays. In the interaction of γ-rays of the energies generated by cobalt-60 with elements such as those comprising concrete the Compton effect predominates.

Assuming that the absorption by steel and concrete of γ-rays arising from a cobalt-60 source is in proportion to their respective densities, then the intensity of radiation which emerges from a 6in reinforced concrete slab, and which has passed transversely through an embedded $\frac{3}{4}$in diameter steel bar, can be shown to be only 16 per cent of that emerging when the rays pass solely through 6in of concrete.

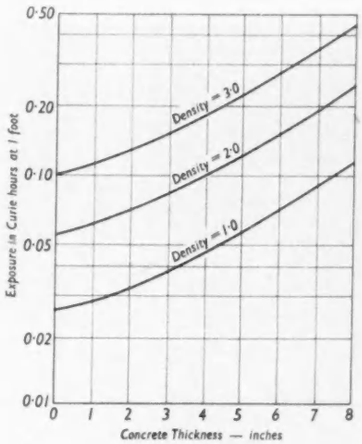
Lead intensifying screens of 0·01in thickness placed in front of and behind the film during exposure to cobalt-60 γ-rays will nearly double the effect of the rays. These screens have two functions : first and foremost they reduce the proportion of scattered radiation reaching the film, thereby increasing the contrast and radiographic sensitivity. Secondly, they provide some intensification, due to a 10 per cent photoelectric effect.

The X-ray films used are coated with emulsion on both sides and vary in speed with the fineness of the grain. Exposure curves for various densities of film can be constructed using a concrete wedge, a standard speed film and a given source, at 1ft source-to-film distance. These relate exposures to thickness of concrete and enable time of exposure to be calculated.

Five γ-ray sources are commercially available for industrial radiography, as listed in the table. The first four of these can be obtained from the Atomic Energy Research Establishment, Isotope Division, Harwell, Berks,[4] and cæsium-137 from the Radio Chemical Centre, Amersham, Bucks.

The emission of γ-rays from such sources compares with that from X-ray sets as

* Cement and Concrete Association, Wexham.



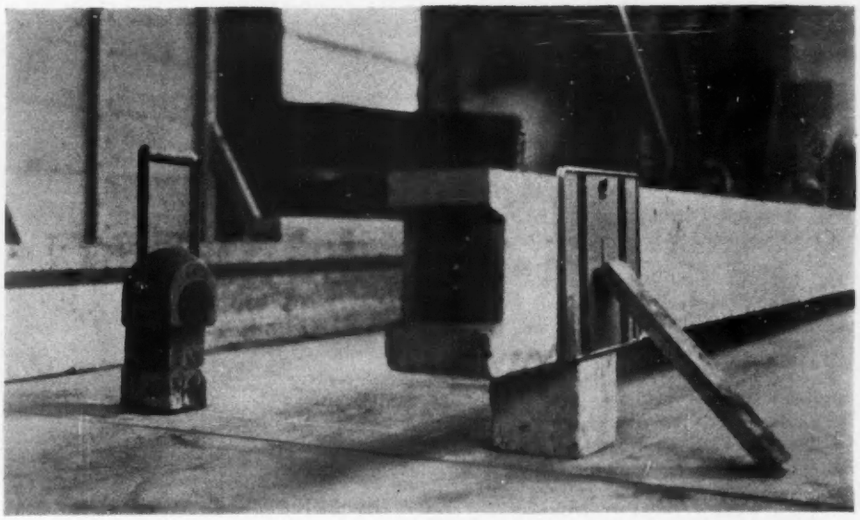


Fig. 1 (above left)—Curves for calculating exposure times for gamma radiography of concrete, using ^{60}Co prepared from a 1 : 2 : 4 : 0·6 concrete wedge. The film was developed for five minutes in ID—19 at 68 deg. Fah. (20 deg. Cent.). The heterogeneity of the concrete produces a spread of results for each film density which covers the small difference in film speed of Kodirex and Ilford Industrial G., the two standard films used. Fig. 2 (above right)—Typical arrangement for radiographing a prestressed concrete beam. The source holder is shown on the left and the film cassette is held on the opposite side of the beam in line with the gamma rays emerging from the front of the source holder. Lead markers on the film side of the beam locate the subsequent radiograph, and markers so placed on the source side of the beam locate the position of the normal source to film line. This is of use for taking subsequert measurements from the radiograph. Figs. 3 and 4 (below left)—Radiographs demonstrating the movement due to vibration of aggregate. By comparing Figs. 3 and 4 the position of artificial aggregate pieces made from wood and lead can be seen before and after vibration. V-shaped markers to the left and bottom of the radiographs locate the lines of centre. Fig. 5 (below right)—Radiograph of a concrete block containing three bars, the centre one being slightly corroded and the one on the right deeply pitted.

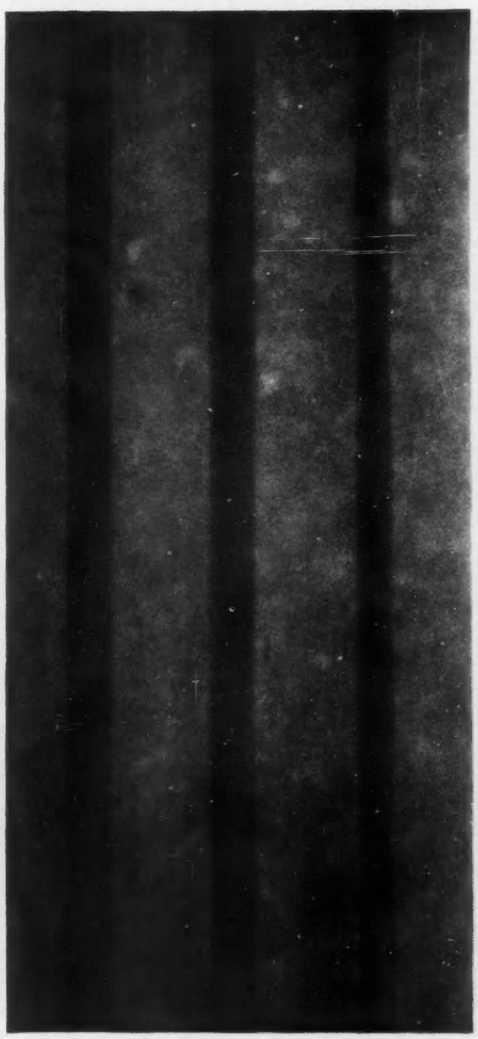


Fig. 6 (right)—Radiograph of an experimental transversely prestressed slab, in which grout has been injected around the post-tensioned wires as far as possible. The lack of grout around the lower wire is shown by the light appearance of the concrete on either side of the wire. The radiographs shown in this article are prints taken from the original transparencies so the reversal of black and white must be borne in mind.

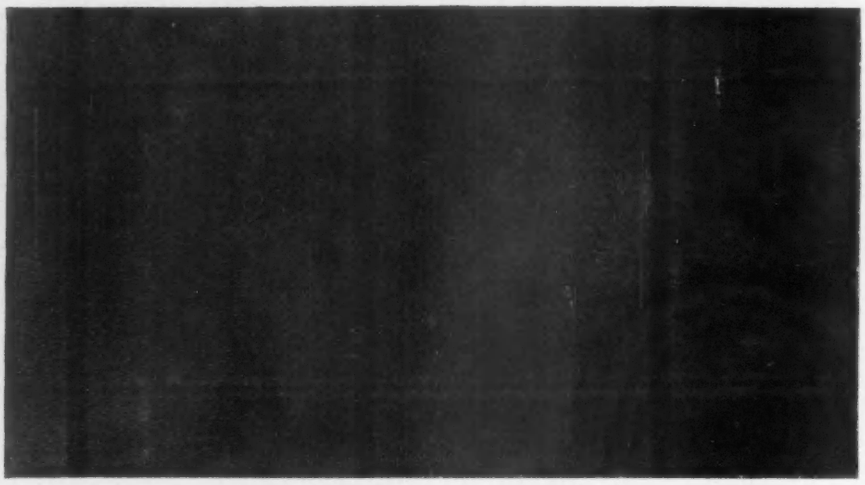


Fig. 7 (below)—Radiograph of part of a Magnel prestressed beam which has additional reinforcing bars, one of which can be partly seen at the top of the figure. The light appearance below the prestressing wires, which are shown passing through a wire cage, indicates a lack of grout in this area. This radiograph was taken through 8in of concrete at a source-to-film distance of 3ft.

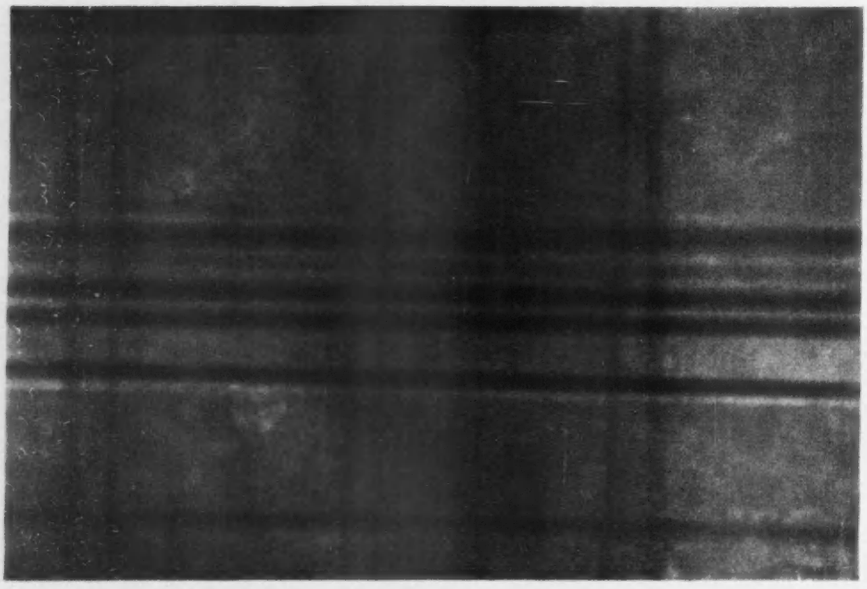
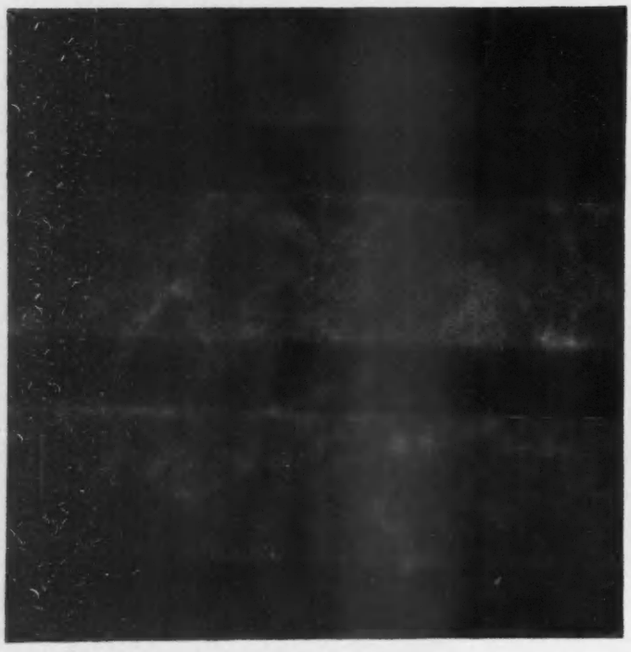


Fig. 8 (below left)—The local difference in density to be expected in badly compacted concrete is clearly distinguished by radiography. The characteristic mottled pattern shown here in a reinforced concrete block is due to honeycombing and can also be seen in Fig. 3, which was taken before vibration. The lower energy radiation from iridium 192 would produce a greater distinction of density and thus show up the honeycombing more clearly.

Fig. 9 (below right)—Depth of cover over reinforcement is well known to be important in preventing corrosion of the steel. This figure shows a radiograph of a reinforced concrete post in which the reinforcement has been displaced during casting and the stirrup holding the bars together has been brought to within $\frac{1}{10}$in of the surface. To show the minimum depth of cover the post was radiographed with one face on the source-to-film line which is at right angles to the film.



follows :—Cobalt-60 and tantalum-182 emit radiation comparable with that from X-ray sets operating in the 1000–2000kV range ; Iridium-192 and cæsium-137 give softer radiation comparable with X-rays generated at about 500kV and 700kV respectively.

γ-ray source	Symbol	Main lines in spectrum (MeV)	Half-life
Cobalt-60	^{60}Co	1·17, 1·33	5·3 years
Tantalum-182 ...	^{182}Ta	Complex spectrum from 0·066 to 1·23	112 days
Iridium-192 ..	^{192}Ir	0·13, 0·29, 0·58, 0·60 0·61	74 days
Thulium-170 ...	^{170}Th	0·084...	127 days
Cæsium-137 ...	^{137}Cs	0·667...	33 years

Thulium-170 γ-rays are comparable in penetration to X-rays generated at about 120kV. Regarding the usefulness of γ-ray sources for examining concrete, it is found that the energies of radiation (which affects both resolving power and contrast on the film) decide the type of source best suited for the work.

Cobalt-60 sources of the strengths which can be readily obtained will penetrate up to 18in of concrete and will define the presence of steel, but, due to the hardness of the radiation, will not show up differences in texture so well as the lower energy sources. The same applies to tantalum-182, which has the added disadvantage of a short half-life. Cæsium-137 and iridium-192 have the right energy range for elements of atomic number similar to those found in concrete. They can be handled in higher activity ranges than cobalt, and manageable sources can penetrate up to 10in of concrete. Iridium suffers from having a short half-life, and cæsium sources are expensive. The low energy of thulium-170 makes it useless for concrete radiography.

The sources are supplied as right cylinders, of 2mm, 4mm and 6mm diameter. A small aluminium alloy capsule encases the source and shields any β radiation. This capsule also provides a fixing tag, which facilitates handling and identification. The radiation shield usually takes the form of a container made from a lead or tungsten alloy with a conical outlet of about 60 deg. solid angle which produces a beam of rays. Many devices are available commercially, which vary in design and in the technique of opening the aperture. In some, the source is set eccentrically in a rotating cylinder within the outer shield so that, by turning the centre through 180 deg., the source is brought in front of the aperture. Others have the aperture sealed by a removable conical plug of heavy metal.

The main advantages of such sources for radiography, compared with X-ray sets, are their small bulk, mobility and relatively low cost. Higher radiation outputs can be obtained with X-rays, however.

Preparation of a Radiograph

A radiograph is prepared by exposing an X-ray film, placed between thin lead screens in a lightproof cassette, to the γ-rays which have passed through a specimen. A typical set-up for radiographing a concrete beam is shown in Fig. 2.

The time in hours of exposure for a given source strength and thickness of material is given by :

$$t = \frac{MFD^2}{S},$$

where M is the material thickness factor (in curie-hours†) for exposures at 1ft arrived at by experiment using a wedge of the material and obtaining measurable densities on a standard film ; F is a film factor related to a standard film, and taking into account the relative speed of the various grades of X-ray films used ; D is the source-to-film distance in feet, and S is the source strength expressed in curies. As an example, a radiograph of 4in of concrete taken on Ilford Industrial G or Kodak Kodirex film and using a 500 millicurie source at 18in source-to-film distance, will require twenty-seven minutes to give a film density of 2. A graph of material thickness factors and their relation to thickness of concrete, using standard Ilford X-ray film Industrial G, is shown in Fig. 1.

† 1 curie = $3·7 \times 10^{10}$ disintegrations per second.

The source-to-film distance chosen depends upon the sharpness of detail required. The finite size of the source results in a penumbral unsharpness effect which is only reduced by increasing the source-to-film distance and decreasing the object-to-film distance. As the time of exposure is proportional to the square of the source-to-film distance, a balance must be achieved between overlong exposure and sharpness of radiograph.

Experimental Work

For the purpose of this work, a 170 millicurie cobalt-60 source was obtained from Harwell, and loaded there into a source-holder of the E.R.D. type. This source was used throughout the series of exposures described. The hard γ-rays generated by cobalt-60 are best suited for distinguishing between large differences in density such as that of steel and concrete and for penetrating up to 18in of concrete. For observing features of concrete such as changes in density or the presence of grouting, a softer radiation of the kind obtained with iridium-192 is more suitable.

As no data existed for the radiography of concrete with cobalt-60 a wedge of concrete was prepared of a standard 1 : 2 : 4 mix and exposure curves were constructed for standard X-ray film and 1ft source-to-film distance. These curves cover the standard Ilford and Kodak films, Ilford G and Kodirex.

Examination of Concrete

Concrete specimens suspected of being honeycombed or cracked were obtained and radiographed. Their condition was subsequently confirmed by breaking open the specimens.

Cracks.—A piece of spun pipe which had shown an abnormal permeability to water was considered to be cracked below a coating of bitumen. The outside of the pipe was crazed and no definite crack could be seen from either side, so a radiograph was prepared, using a set-up similar to that shown in Fig. 2. The radiograph clearly showed a crack normal to the surface and travelling in from the edge of the specimen.

Honeycombing.—The honeycombing in a reinforced concrete specimen is distinguishable as white patches on the radiograph reproduced in Fig. 8.

Movement of Aggregate Under Vibration.—Observations of movement of aggregate before and after vibration were made using pieces of artificial aggregate prepared from small cylinders of wood drilled longitudinally and plugged with lead such that their size and density was that of the bulk of the aggregate used. In the example reproduced in Figs. 3 and 4, the mix was prepared, using a fine granite dust carefully graded to cement fineness, in place of cement, and mixing this inert material with aggregate in a standard 1 : 2 : 4 mix with a water/granite-dust ratio of 0·5, and aggregate of ¼in maximum size.

Radiographs were taken before and after two minutes' vibration of this mix in a waterproofed wooden mould of internal dimensions 4in by 9in by 12in on a Wexham table vibrator.

Inert granite dust was used instead of cement for this demonstration to allow time for an exposure before vibration on the only film available at the time, Ilford Industrial C, which has a speed one-thirteenth that of the standard film. Observation could be made on normal concrete, using fast film and, possibly, chemically retarded cement.

Examination of Reinforcement

Location.—The location of reinforcing bars, important for core cutting, measuring depth of cover, &c., is demonstrated by the radiographs in Figs. 7 and 9. Fig. 9 shows a cover of concrete over a wire stirrup of only $\frac{1}{16}$in. Fig. 7, which is a radiograph of the end of a prestressed beam, demonstrates the possibility of identifying the type of reinforcement. The reinforcing bars, prestressing wires and wire cage can be identified and the light shading below the wires shows a lack of grout in this area.

Condition.—In an attempt to show corrosion of bars, a concrete block 4in by 9in by 12in was made with three bars sunk into it longitudinally. The condition of the three bars was such as to simulate no corrosion, slight corrosion and severe pitting. A radiograph of the block is shown in Fig. 5 and, though the slight corrosion cannot be seen, severe pitting is obvious from the profile of the third bar.

Grouting.—It was suspected that the prestressing wires in an experimental slab were not properly grouted so the slab was radiographed in the suspected area (see Fig. 6). The light area around the ⅛in prestressing wire which can be compared with its neighbour, indicates that grout had not penetrated to that spot.

Conclusions

It is considered that sufficient demonstration has been given of the potentialities of γ-radiography to enable its use in concrete technology to be considered. There are further techniques which await trial, such as stereoscopic radiography of reinforced concrete and observation of the efficiency and segregation of grouting by adding to the grout an inert attenuator such as barium sulphate.

As the prefabricated concrete member becomes more valuable, there will be a greater demand for it to be tested in a non-destructive way before dispatch. The day may come, therefore, when inspection by γ-radiography will be as important in concrete technology as it is in foundries and heavy fabricating shops.

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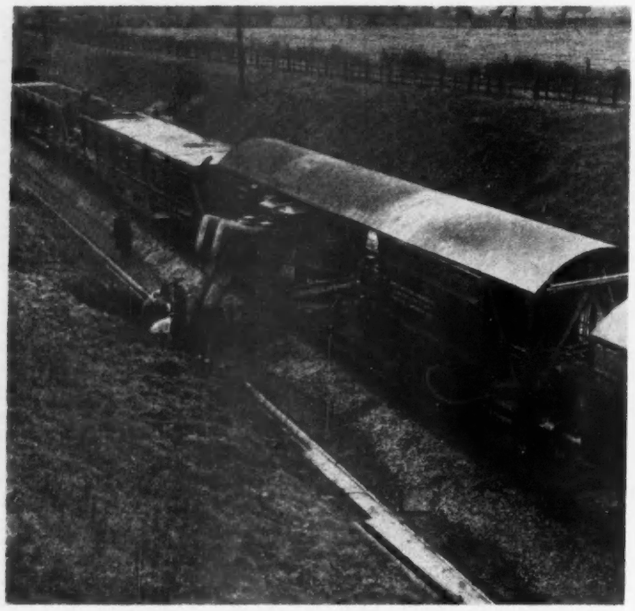
Magnetic Vee Block.—To facilitate clamping work on machine tables, James Neill and Co. (Sheffield), Ltd., has introduced a magnetic vee block. Both contact faces of this block are magnetised by a turn of a switch, so that the work secured in the appropriate "vee" slot and the block is firmly applied to the machine table. The end of the block is also energised so that work can be mounted vertically by turning the vee block on its end, using either or both "vees" as necessity arises in the upright position. The maximum capacity of the larger vee in the block is 2⅛in but this can be opened out by machining if a slightly larger capacity is required. The smaller vee is made to accommodate ⅞in diameter workpieces. The blocks are 4in long, 2⅛in wide and 3⅛in high and can be supplied in single units or in matched pairs.

Mast Erection Equipment for Railway Electrification



A mast erection equipment developed by B.I.C. Construction Company, Ltd., and built by Wharton Engineers (Elstree), Ltd., is now in operation on the section of the British Railways main line electrification project near Crewe. This equipment is stated to be capable of installing about a mile of the masts for overhead conductor supports along one side of the track in a daily period of six hours. It consists of three trains—an auger borer train, for making the foundation holes ; a mast placing train, and the concrete mixing and placing train which is here shown in operation

WHEN carrying out the contract for the electrification of the Shenfield-Chelmsford-Southend line in 1955 British Insulated Callender's Construction Company, Ltd., put into service a prototype mechanical equipment for installing the concrete foundations and erecting the masts for the overhead conductor wires. This equipment not only enabled the work of mast erection to be carried out at a considerably higher speed than previously achieved, but it also reduced the amount of labour required to a fraction of that needed when excavating the foundation holes by hand and placing the concrete manually. It proved so successful in use that, when railway electrification contracts were placed with the B.I.C.C. group under the British Railways modernisation plan there was developed a new and improved equipment based upon that previously used, but incorporating a number of changes and improvements which experience with the prototype showed were desirable. In particular the mixing and placing plant for the concrete mast foundations has been completely redesigned to provide a considerably increased capacity, combined with a far higher placing rate than was possible with the prototype equipment. This new equipment is expected to enable foundations to be placed at a speed corresponding to that at which the holes are bored, which was not possible with the original plant. The new equipment, like the prototype, was designed by B.I.C. Construction Company, Ltd., in conjunction with Wharton Engineers (Elstree), Ltd., the firm which undertook the construction of the complete plant, and also British Railway engineers.

The mast installation equipment consists of three separate trains which are spaced at intervals along one line of track. In the sequence of operations a mast foundation hole is bored with earth auger equipment on the first train. When this train has moved on to the next foundation point the following train, which comprises a diesel self-propelled railway crane hauling a line of trucks with a supply of masts, moves into position. A mast is placed in the hole by this crane and left supported and centred in the hole by a temporary ground frame. The third and final train includes a concrete mixing and placing plant together with the necessary aggregate, sand and water tank wagons. In one of the trucks of this train there is a diesel electric generator set which supplies power for all the electrically driven plant ; air compressors, water pumps and a maintenance work bench. When the concrete foundation placed by this train has set, the temporary mast-supporting ground frame is removed and returned in due course to the first train for re-use.

The new equipment is now working on the Manchester-Crewe electrification contract and its principal units are to be seen in the photographs we reproduce. It will be appreciated that when this equipment is in use full occupation of one track is required, but its speed of working and high degree of mobility are such that even with limited periods of occupation it is vastly quicker than the methods used hitherto.

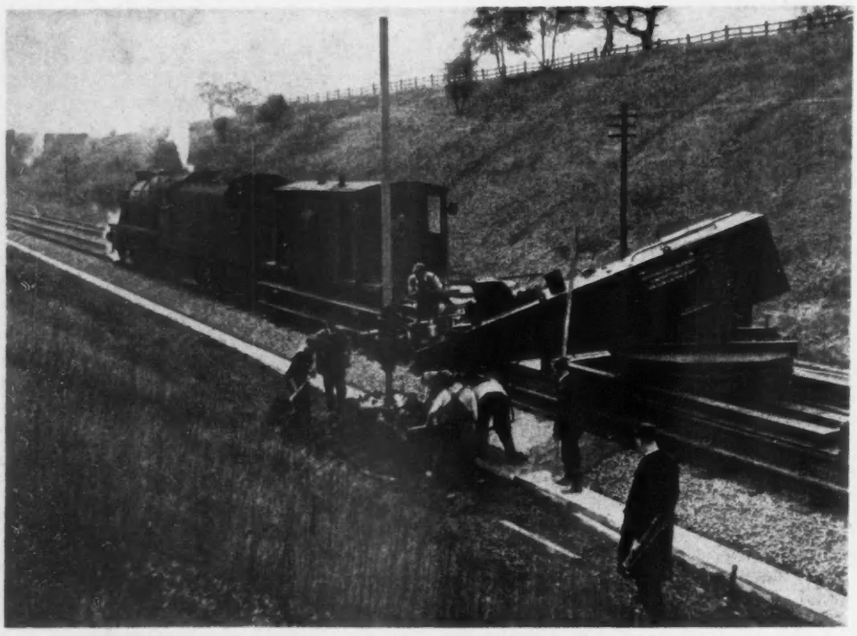


Fig. 1—Earth auger boring equipment on first train. With this equipment holes from 2ft to 3ft 6in. in diameter can be bored up to 15ft from the centre-line of the rail track

Hole Boring Train

The hole boring wagon of the first train is shown in Fig. 1 on this page and the arrangement of the boring equipment can be seen in the drawing, Fig. 2. It is generally similar to that used on the prototype equipment but incorporates certain modifications to give a larger working range and increased rigidity during drilling.

The earth boring equipment consists essentially of an earth auger mounted at the extremity of a rigid welded boom which cantilevers out from a turntable assembly on the rail wagon. The auger can be used to bore holes from 2ft to 3ft 6in diameter down to a depth of 14ft below rail level, and up to a distance of 15ft from the centre line of the rail track. If it is necessary at any later date to increase the drilling capacity of the auger a longer rack bar can readily be fitted. Power for driving the auger head and a hydraulic pump delivering pressure fluid for the ancillary equipment is supplied by a "P.6" diesel engine enclosed in the

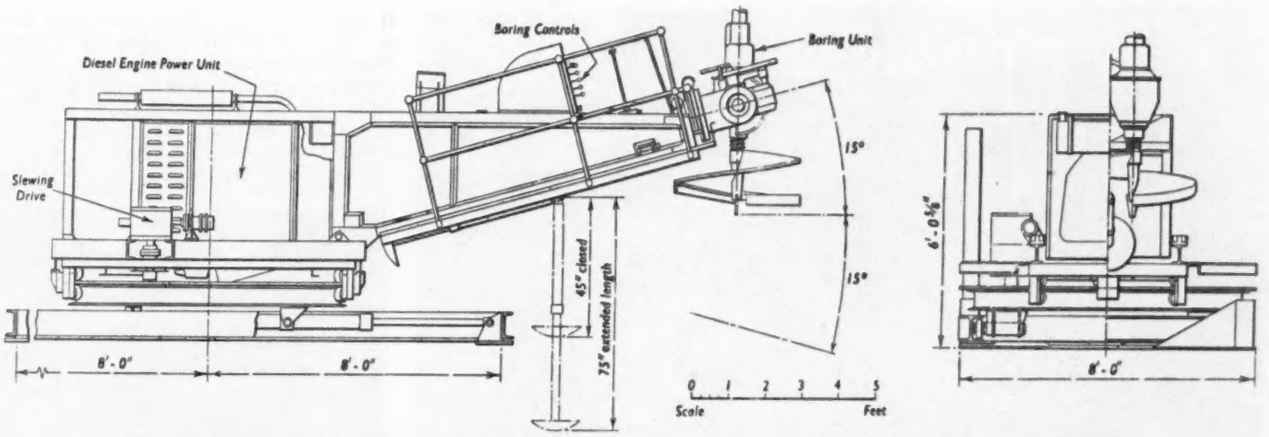


Fig. 2—Equipment for boring foundation holes installed on first train. The second train places the masts in position in the holes.

boom rear-end structure. This structure is carried by supporting and hook rollers on the machined tracks of a circular base. The sub-frame of this base forms a carriage supported by rollers in machined tracks in the inner webs of two heavy longitudinal girders bolted to the wagon frame. A pinion driven by a hydraulic motor meshes with an internal rack on the circular base, and through this motor the boom assembly can be rotated through a full circle on its carriage, to swing the auger out over either side of the truck.

A hydraulic ram with a stroke of 6ft which connects the boom carriage to one

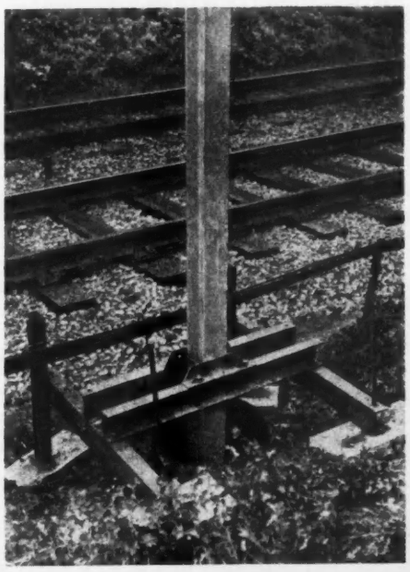


Fig. 3—Augered hole and mast held by ground frame prior to the pouring of concrete

end of the longitudinal track is used to position the carriage along the wagon. The base of the boom structure is pivoted on the turntable at its front and at the rear of the structure is connected to the base by a hydraulic jack. By extending this jack the boom assembly can be tilted through some 30 deg. to facilitate the positioning of the auger axis in relation to the track side conditions and enable it to clear line-side obstructions. With the wide range of boom adjustments available the truck can be approximately positioned by the site of the hole to be bored and final auger settings made by manœuvring the boom—which can be traversed, rotated, raised or lowered by hydraulic power—and the pivotally mounted auger head tilted to provide for practically any adjustment required in accordance with conditions or angle at which the hole has to be bored.

The engine drives the auger head through a clutch, a three-speed gearbox and reverse universal joints and a long transmission shaft, a pair of hand-controlled clutches being also incorporated in the assembly. These clutches control the rotational speed and the pressure on the boring head. The rate of penetration depends entirely on the nature of the earth to be bored. An operator's platform is built along one side of the boom with the controls for all motions conveniently situated close to the auger head, where there is a clear unobstructed view of the boring operation. When it is required to bore large diameter holes in heavy earth additional support is provided for the boom by a leg which is pivoted on the underside and can be let down and extended by hydraulic jacks.

Operating experience with the equipment has shown that, under the conditions generally encountered, the time taken to bore holes 8ft to 10 ft deep at 220ft centres is in the region of seven to ten minutes, including the time required for train movement and positioning of the auger. When the boring operation has been completed the temporary ground frame illustrated in Fig. 3 is placed in position over the hole to centre and support the mast installed by the mobile crane of the second train.

Concrete Placing Train

The prototype train which was used for mixing and placing the concrete foundations has been replaced by a completely new set of vehicles and equipment. The original train incorporated a concrete mixing wagon carrying two electrically-driven weigh batching concrete mixers, with a placing unit between them. The cement and aggregate was supplied to these mixers by hand barrows on plank runs from adjoining wagons. In the new train continuous concrete mixers are fed with aggregate by a conveyor line from specially designed hopper wagons, as shown in Fig. 4.

Each of the new hopper wagons consists of a standard flat truck on which a fabricated structural steel framework has been erected to carry a line of six welded steel plate hoppers, each of which takes up to 6½ tons of sand or ballast. A pair of plate conveyors runs the full length of the truck beneath the hoppers, one for carrying sand and the other for ballast. One of a pair of twin doors in the bottoms of the hoppers opens immediately above each conveyor, and the sliding plates which seal these doors are operated as required by wormshafts

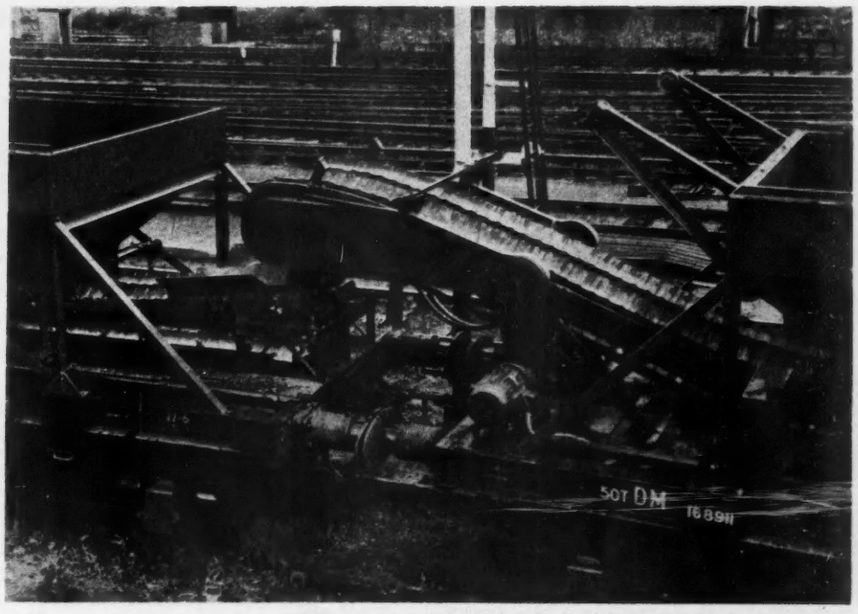


Fig. 4—Hopper wagons with materials conveyors in the operative position

Fig. 5—Concrete-mixing-and-placing vehicle in use with mixers swung out to deliver directly into a large excavation. The sand and ballast delivery conveyors of a hopper truck can be seen feeding the transfer conveyors

turned by means of handwheels at the side of the truck. By opening the appropriate door each hopper can be discharged on to either of the conveyors according to its contents. The rate at which material is drawn from a hopper is controlled by a vertically adjustable gate.

The conveyors on the wagons are driven through reduction gearing by 4 h.p. motors, and they are of the "W.S." all steel design made under licence in this country by Wharton Engineers (Elstree), Ltd. Each conveyor line comprises a series of overlapping curved steel pans coupled to each other by a driving chain. Brackets fitted to the pans at intervals support the conveyor line through flanged rollers running on a rail track bolted to the main hopper support structure. At one end of the truck, just before the conveyors begin their run beneath the line of hoppers, an inclined plate is set on each side. These inclined plates serve to prevent spillage of materials delivered on the conveyor from that of the previous truck in the train. At the other end of the truck the conveyors pass over a jib structure, the head of which extends outwards over the anti-spill plates of the conveyors of the truck in front. These jibs are pivoted at their lower ends to the main structure, and by means of a hand winch can be folded back and locked on the framework whilst a wagon is in transit as a single unit.

When the train of hopper wagons is in service the conveyor jibs are inclined outwards, as shown in Fig. 4, so that each conveyor line feeds material to the appropriate conveyor of the vehicle in front. In this way sand and ballast are fed forwards continuously to the concrete mixing and placing vehicle from selected hoppers, at a rate controlled by the height of their striking plates. As each hopper is emptied other hopper doors are opened in succession along the train.

The concrete-mixing-and-placing vehicle is illustrated in Fig. 5 and the drawing Fig. 6. It consists of a standard low-loading truck on which there are mounted a materials transfer conveyor, two continuous concrete mixers, a placing unit and a 12 ton capacity cement storage hopper. It is expected that one continuous mixer will provide sufficient concrete for normal requirements, but two machines and their means of supply have been installed for standby purposes in the event of one breaking down ; or for working together where particularly large excavations have to be filled.

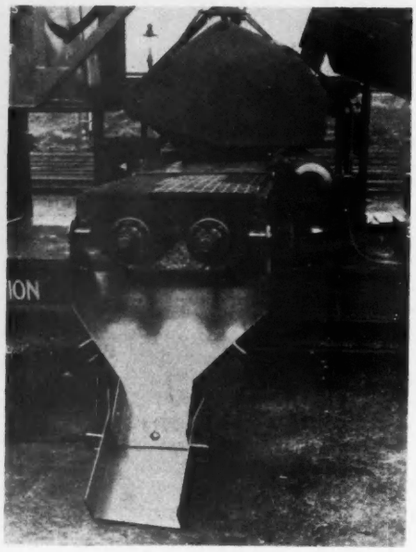


Fig. 7—Concrete placing equipment swung out to deliver concrete down chutes to a lineside excavation. The delivery of the continuous mixer can be seen on the right depositing concrete into the placer hopper

The transfer conveyor is of similar plate construction to those of the hopper wagons and it receives materials from the overhanging jib of the adjoining hopper wagon. The materials are elevated by the transfer conveyor and deposited into the feed hoppers of the continuous mixers through swivelling chutes, which can be positioned in accordance with the mixer in use and the material on

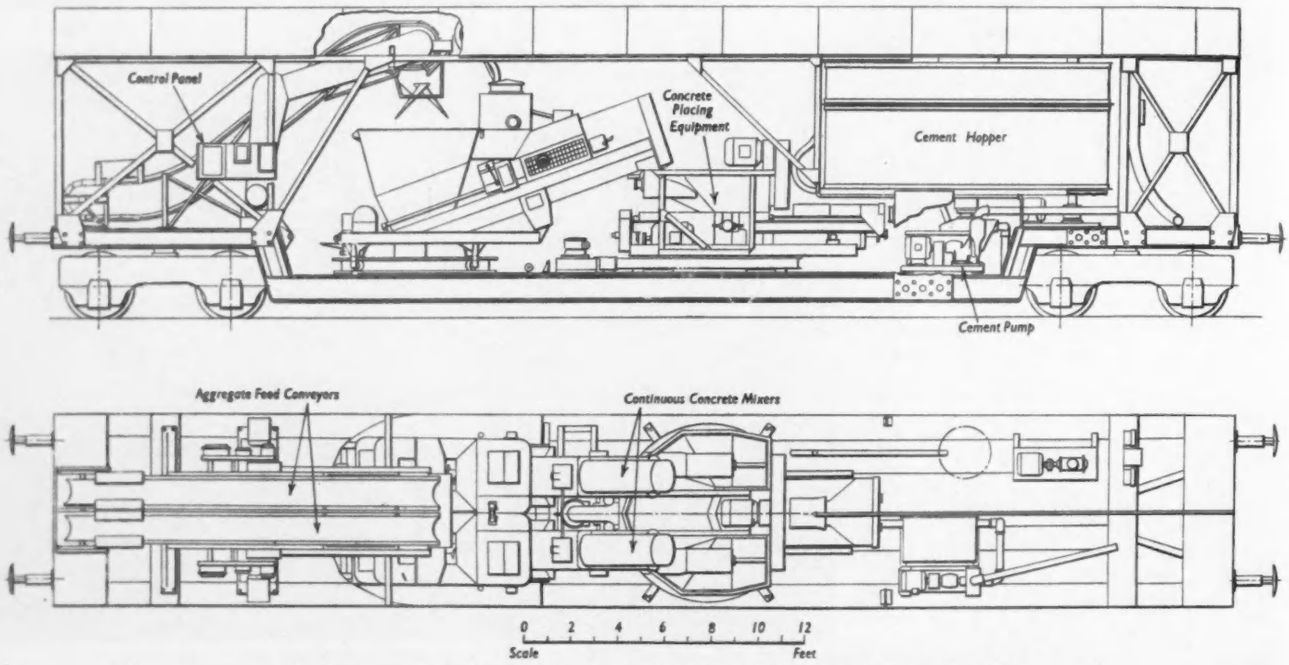


Fig. 6—Arrangement of equipment on the concrete-mixing-and-placing vehicle of third train

the individual conveyor lines. Cement is delivered to metering hoppers above each mixer by a motor driven pumping set beneath the main storage hopper. Water is pumped to the vehicle from an adjoining tank wagon. The two continuous mixers are arranged side-by-side on a fabricated steel base frame and each receives sand and ballast from the transfer conveyor in a large hopper at the rear. This hopper is fitted with a vertical partition plate which can be moved along its length to determine the size of the sand and ballast compartments in accordance with the concrete mix required. A screw conveyor in the base of the aggregate hopper draws sand and ballast forwards through a second compartment where a metered supply of cement is deposited. The materials then pass on into a scroll mixing section where a metered flow of water is sprayed on to them from above in the initial stages of mixing. This mixing process is continued by the action of the scroll conveyor until the concrete drops in a continuous stream from the end of the mixer either into the hopper of the placing unit or directly into an excavation at the side of the line.

Each of the mixers is driven through a variable speed gearbox by a 7½ h.p. motor, and is designed to deliver from 11 cubic yards of concrete per hour at low speed up to 18 cubic yards per hour at top speed. The twin mixer assembly is mounted on a turntable by which it can be swung through 90 deg. to deliver concrete directly on to the side of the track or into vehicles if required.

The placing unit, Fig. 7, into which the mixers deliver concrete consists essentially of a receiving hopper into the base of which is fitted a sliding trough fitted with a twin screw conveyor. This assembly is mounted on a turntable so that it can be swung round and the trough extended out over the side of the vehicle to deliver concrete when the screw conveyor drive is engaged. A chute at the outer end of the placing trough can be positioned to deliver concrete to excavations up to 12ft from rail centre, and this distance can be readily increased by the use of an extension chute.

In normal practice the continuous mixers feed concrete into the placer unit hopper whilst the train is moving between mast erection points. This enables the trough to be positioned without delay and makes available an immediate supply of concrete. The screw conveyor is driven by a 7½ h.p. motor and its trough is extended and retracted through rack and pinion gearing by a 7½ h.p. motor. The equipment of this vehicle includes two pneumatic vibrators, which are operated continuously during the placing of the concrete, and a 3in drainage pump for clearing holes of any water before foundations are placed.

The main control panel for the train is situated on the structure of the transfer conveyor. When the starter for the main material conveyor line is operated the motors of the individual hopper wagons are switched on in sequence along the train. As successive wagons furthest from the mixing truck are emptied their conveyor motors can be stopped by individual control gear on the wagons.

The power vehicle is equipped with a 105kVA diesel-electric generator which provides sufficient power for the whole of the train. It also carries two rotary compressors each delivering 65 cubic feet of air per minute at 100 lb per square inch for the vibrators and ancillary equipment, and two centrifugal pumps of 20 gallons per minute capacity.

Large Solid-Rotor Asynchronous Generators

By P. RICHARDSON, M.I.E.E.*

In a paper presented for discussion to the supply section of the Institution of Electrical Engineers, London, on February 26, Mr. P. Richardson considered the design and application of large solid-rotor asynchronous generators. In particular, he examined the design problems posed by stator-core-end heating and rotor surface heating. He also reviewed the possibilities of applying solid-rotor asynchronous generators as shunt reactors or as one component of a cross-compound generating set. Abstracts from the paper are reproduced here.

THE asynchronous generator has not been extensively used for power generation, although its characteristics and application have been reviewed in a number of publications and textbooks. Such a generator is characterised by the absence of an exciting winding on the rotor, the excitation being provided by the system to which it is connected. It has been employed to utilise small sources of energy, for example, small rivers where generators can be driven by a turbine having a constant gate opening. When water is plentiful an appropriate amount of power will be generated and when water is low the plant will run light. The systems to which such generators are connected must be relatively large, but as voltage regulation is carried out on the synchronous machines, the amount of control and regulating gear on the asynchronous machines is small and makes them most suitable for non-attended stations. The asynchronous generator has also been applied to industrial plant where process energy is available as a by-product.

Asynchronous Operation

It is well known that an asynchronous motor, if driven above synchronous speed, will feed power back into the system, the power bearing a definite relationship to the slip—a reflection of the conditions obtaining when operating as a motor. The simple circle diagram illustrating the operation of such a machine both as a motor and a generator is shown in Fig. 1. Briefly A' is the no-load operating point, and the current vector OA' has two components, a reactive component OA which produces the flux and a power component $A'A$ which is in phase with the supply voltage and is proportional to the no-load losses. The point B is determined from the short-circuit input at full voltage, and the locus of the current vector OP lies round a circle through $A'PB$ with $A'C$ as a diameter.

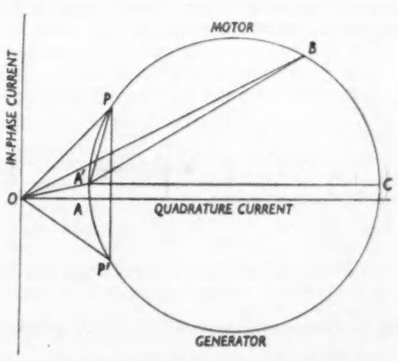


Fig. 1—Simple circle diagram for asynchronous machine

The load-current vector OP has two components, OA' and $A'P$, the latter balancing the ampere-turns on the rotor. The rotor conductors move at slip frequency with respect to the stator flux and the voltage thus induced in the rotor conductors causes current to flow in the rotor circuit. As the load is reduced so also are the slip, the induced voltage and the current vector $A'P$, until at synchronous speed there is no rotor current. If the power flow is reversed and the motor is driven above synchronous speed, current again flows in the rotor conductors but in the reverse sense, and the current locus moves round the locus of the diagram, as shown by OP'.

It will be seen that when generating power the machine will still be taking its reactive magnetising current from the system as when running as a motor, so that the system to which it is connected must be able to supply a reactive component of current. It will also be evident that such magnetising currents may be drawn conveniently from a system containing capacitance such as a long transmission line or cable system.

Self-Excitation.—If a capacitance is connected across the terminals of an asynchronous motor and the latter is run to speed, it will generate a voltage depending upon the speed of the motor and the magnitude of the capacitance. This is illustrated in Fig. 2,

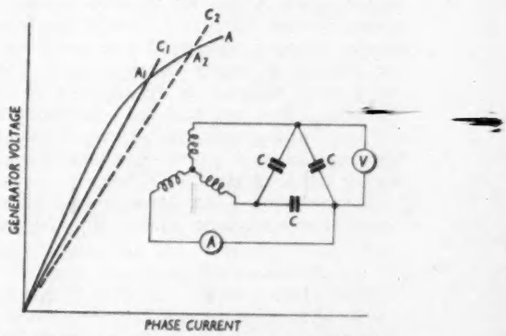


Fig. 2—Magnetisation and capacitance characteristics

which shows the open-circuit excitation characteristic of an asynchronous motor, together with a capacitance characteristic. The voltage generated will be that corresponding to the intersection of the capacitance characteristic with the open-circuit characteristic, i.e. OA_1. If the capacitance is increased a new capacitance characteristic will be obtained and the voltage generated will be OA_2. The generator would have a drooping load characteristic, but it would be possible to obtain a compounding effect by the insertion of additional series capacitance.

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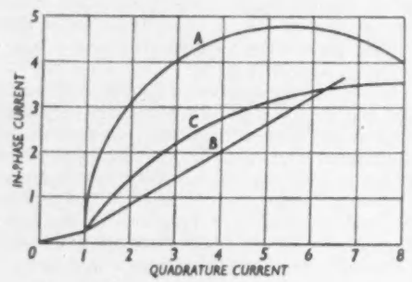
Such a generator would be capable of supplying power through a system containing capacitance, but the voltage and frequency would depend on the load ; this condition of operation, which is not envisaged in the present paper, would require study where there existed a possibility of an asynchronous generator together with a portion of the network becoming isolated from the synchronous network to which it was connected.

Characteristics of a Solid Forging.—The conventional asynchronous motor has a laminated rotor with slots round the periphery carrying the rotor winding, and a similar construction is adopted for relatively small asynchronous generators, the winding being in the form of a squirrel cage. The paper is concerned with generators of large output at high rotational speed where it is essential to utilise a solid rotor forging for mechanical reasons. Clearly, secondary currents will circulate in the rotor surface of a solid rotor and give rise to torque, but in view of the resistance offered to the flow of such currents, consideration must be given to the amount of copper which can be incorporated in the form of a damping or squirrel-cage winding. Various methods of calculation may be applied to determine the characteristics of solid rotors, and while the curves of Fig. 3 were determined for a relatively



A—Normal induction motor.
B—Solid mild steel rotor.
C—Mild steel rotor with copper damping bars.

Fig. 3—Characteristics of various types of rotor

small machine, similar effects will be observed on large units. Curve *A* represents the characteristic of a normal asynchronous motor, curve *B* that for a motor having a solid mild steel rotor, and curve *C* that for a motor having a solid mild steel rotor with the addition of copper damping bars. The latter curve shows that the addition of the damping bars modifies the characteristic obtained with a solid steel rotor so that it approaches that of a normal laminated rotor with a full squirrel-cage winding.

Power Factor.—The power factor of an asynchronous machine is inherently low, and

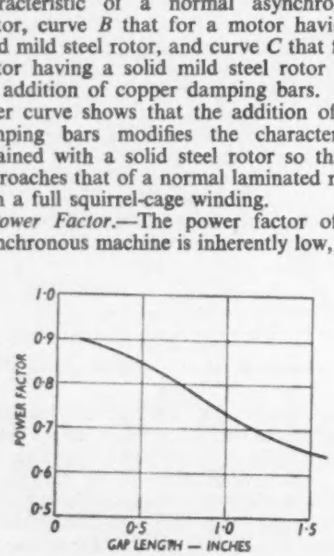


Fig. 4—Variation of power factor with gap length

while in certain circumstances such as in a shunt reactor, this may be turned to advantage, the problem with asynchronous generators in general is to keep the power factor high. The curve of Fig. 4, which represents the manner in which the power factor may be expected to vary with length of air gap, has been drawn for a large asynchronous generator whose rotor diameter may be of the order of 36in. It will be clear that for economy in magnetisation the gap must be kept to a minimum. In designing a generator with a small gap, care must be taken to avoid overheating of the rotor surface due to eddy currents set up by irregularities in the stator flux and the ampere-turn distribution. These problems are dealt with in more detail later.

In most large generators the air gap forms part of the ventilation circuit, and much care is taken to keep the average temperature of the cooling medium round the rotor surface as low as possible. The restriction in gas flow by the use of a small gap therefore introduces a real problem in ventilation.

Switching.—The asynchronous generator does not carry an exciting winding, and it is put on to the bars of a system by running up to normal speed and switching in without any need for close synchronising as in the case of a synchronous machine. There is, however, the initial current rush associated with the establishment of conditions in the magnetic circuit similar to those which occur when switching in a transformer. Such switching transients can be reduced by the insertion of a reactor during the starting period, but as this would reduce the maximum torque developed, it is essential to short circuit the reactor before loading up the generator.

Fault Current.—An advantage of the asynchronous generator is that under fault conditions the fault current decays rapidly and is negligible after the first one or two cycles. The excitation is derived from the system to which the machine is connected, and under three-phase fault conditions the system voltage disappears. There are, however, at the time of fault, flux linkages associated with the rotor circuit, and as these cannot change instantaneously, rotor and stator currents will flow in such a manner as to maintain the flux linkages. This condition is identical with that associated with the sub-transient reactances in a synchronous generator and the time constant will be similar, i.e. about 0·03 second. While the asynchronous generator does not impose a duty on the circuit breakers, the high initial fault current must be considered when designing the protective gear system.

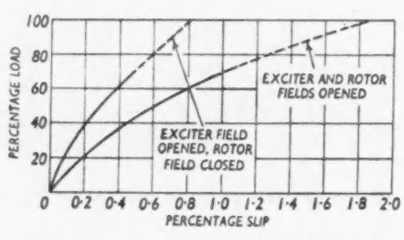


Fig. 5—Asynchronous operation of 2500kW generator

Tests on 2500kW Generator.—Some time ago, tests were carried out on a 2500kW generator to investigate asynchronous operation. The generator was operated synchronously at a predetermined steady load and the exciter field circuit was then broken ; readings were taken of the slip and stator current, following which the main field circuit was broken and readings again taken. On restoration of the original excitation conditions the generator pulled into step without difficulty. These tests were repeated at various loads, and Fig. 5 shows the relationship between load and slip. It will be seen that the slip is a minimum with the main field circuit closed, this being due to the effect of the rotor winding. The amount of secondary loss in the rotor can be estimated from the load and the slip at that load, and with the main field circuit closed the rotor loss at full load is of the same order as the excitation normally required for rated load. When operating asynchronously it was found that swinging of the stator current occurred owing to the non-uniform reluctance of the magnetic rotor, which was slipping with respect to the stator field, but such surging would not be expected with a solid rotor or one with uniformly distributed damping circuits.

These tests appear to demonstrate that without excitation the losses in the rotor are of the same order as those obtaining when fully excited at rated load. An examination of the available evidence over many years has indicated that generators have been known to lose excitation, in some cases owing to a failure of the exciter field, while in other cases the rotor field switch has been opened. As far as the author has been able to ascertain, there have been no reports of overheating or damage to the rotor from such operation. Nevertheless, as shown [in Section 3.6 of the paper], overheating of the stator may occur, and loss of excitation introduces a problem of protection. It is considered that loss of excitation alarms should be fitted wherever possible.

[Here the author gave details of his investigations into stator-core-end heating—including the effect of short circuit ratio and magnetic end bells—and rotor surface heating.]

Applications of the Asynchronous Generator

Shunt Reactor.—The amount of leading current necessary to charge transmission lines, particularly where they are being installed at a greater rate than generating plant, introduces serious difficulties in connection with the stability of the system, and consideration has had to be given to the installation of shunt reactors to offset the line charging. It would therefore seem that, in circumstances such as these, it should be possible to make use of the characteristics of the asynchronous generator, which relies upon the capacitance in an overhead line or other synchronous plant to provide its excitation. In addition to performing the duty of a shunt reactor, the generator would, of course, provide useful power to the system.

Under conditions of light load the corrective effect of an asynchronous generator would be that corresponding to the no-load magnetising current. As the load built up on this generator, the out-of-phase component would increase [as demonstrated in Fig. 1] but as the increase would be supplied by the synchronous machines, it would merely serve to increase their stability.

Cross-Compound Units.—In view of the increasing demand for large units, power engineers are turning their attention to the application of the cross-compound unit ; in certain cases this may consist of two high-speed lines, and in others a high-speed and low-speed line. Where the latter scheme is envisaged it would appear that the asynchronous generator may have a useful application on the high-speed line. With such a scheme, the high-pressure high-temperature steam is fed into the high-pressure turbine on the high-speed line, which runs at the maximum permissible speed. In this manner advantage is taken of the small-diameter turbine spindle, which is advantageous from the point of view of

thermal mass and blade annulus. The high-pressure line feeds into the low-pressure line, and in general the latter runs at half the speed of the high-speed line, i.e. the generator has four poles instead of two. In this case it becomes possible to provide an exhaust annulus capable of handling the large volume of low-pressure steam.

In large units an intermediate-pressure section is provided between the high-pressure and low-pressure turbines, which can be incorporated in the high-speed or low-speed line or in some cases split, part of the section being on each line. Another factor controlling the arrangement of the turbine cylinders is the overall length of the unit, and as far as possible the units are proportioned to occupy a similar length. The arrangement of the turbine does not fall within the scope of this paper, but, broadly speaking, the powers available from the high-speed and low-speed lines are similar, although a reasonable variation is feasible in either direction.

As already explained, the asynchronous generator draws its excitation from other units, so that when it is used it is convenient to regard a cross-compound unit as an entity ; i.e. the low-speed generator must provide the excitation for the high-speed generator. To illustrate the argument a hypothetical case of a 200MW cross-compound unit, rated at 0·85 p.f., is considered. This is split into two equal lines each rated at 100MW. It is also assumed that the high-speed unit containing the asynchronous generator will deliver its output at a power factor of 0·9 leading. The unit as a whole must deliver 200MW and 123MVAr, and since the only synchronous unit is on the low-speed line this generator must be designed for an output of 100MW and 123MVAr. In addition, however, the low-speed generator must provide the magnetising power for the high-speed generator, which at a rated power factor of 0·9, amounts to 48·6MVAr ; i.e. the low-speed generator must be rated at 100MW and 171·6MVAr, or a rated power factor of about 0·5. Fig. 6 illustrates

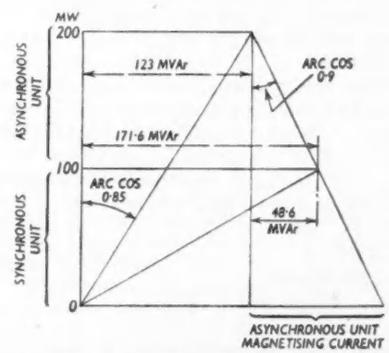
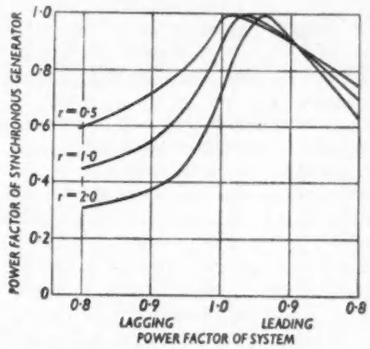


Fig. 6—Determination of rating of synchronous unit in cross-compound arrangement

the foregoing steps which have to be taken to determine the rating of the low-speed generator.

The foregoing arguments have been applied to a unit designed to generate at an overall power factor of 0·85, but if, for example, the loading conditions are such that the rated power factor of the unit becomes unity, the low-speed generator will only have to supply the magnetising current for the high-speed generator ; i.e. its rated power factor will be 0·9 lagging. This is reasonable from the point of view of generator design, and it will thus be apparent that the power factor at which the unit delivers its output has a large effect upon the power factor for which the low-speed generator must be designed. This variation is illustrated in Fig. 7, which shows the relationship between the power factor of the load delivered to the system and the power factor of the low-speed generator for three different ratios of load split, namely 2 : 1, 1 : 1 and 1 : 2. It will be seen that it is advantageous to keep the output of the high-speed unit less than that of the low-speed unit, and that, where the power delivered to the system is at a power factor of unity, the electrical rating of the low-speed generator is not severe.



$r = \frac{\text{Output of asynchronous unit}}{\text{Output of synchronous unit}}$

Fig. 7—Effect of system load power factor on rating of synchronous unit

Where generators are intended to supply long overhead-line systems, an immediate problem is that of stability, and, as is well known, it has been customary in America to design generators having a short-circuit ratio of unity. Such generators must be larger and more expensive than those designed for a lower short-circuit ratio, and the limitations imposed on maximum permissible output by a high short-circuit ratio are such that on modern generators there is an increasing tendency to adopt a lower short-circuit ratio. The type of cross-compound unit described above, instead of having to provide line-charging capacity, in effect utilises it as a means of excitation and thus puts the line capacitance to a useful purpose ; the difficulty of providing generators having a high short-circuit ratio is thus minimised. The characteristic of an asynchronous generator is such that the magnetisation required at various loads changes relatively slowly and thus more closely compensates for line-charging capacity over a wide range of load.

The construction of the high-speed line is more simple and robust than that of the equivalent synchronous generator. The rotor, which would normally have to be of a highly stressed alloy steel, may be replaced by a lower-grade forging, and the use of a highly stressed end bell is avoided. The rotor body end need not suffer the rapid reduction in section normally required to accommodate the rotor end windings, and could be tapered steadily from the body end to give a stiff shaft. The advantages of shaft end stiffness, and consequently high critical speed, are obvious. The absence of an excitation winding avoids the use of slip rings and the associated problem of current collection at high surface speeds.

The normal d.c. excitation of the two units is concentrated into the single low-speed unit, the excitation on that unit being correspondingly increased. Fundamentally the low-speed design of generator can accommodate adequate copper on the rotor without attaining excessive mechanical stresses, and this is particularly evident with the direct-cooled design. The additional exciting current leads to a problem of current collection, but here again the stiffness of the shaft end, the area of slip-ring surface which can be provided and its relatively low surface speed render the current collection problem less difficult. The mechanical stresses in the rotor end bells and in the rotor body are moderate, and for the latter a low grade of steel is probably permissible.

It is evident that the frame size and efficiency of the proposed units on the high-speed and low-speed lines will not be identical with what might be regarded as the normal synchronous arrangement of units, and the overall economic position can best be illustrated by comparing details of the units required to supply a system load of 200MW at 0·9 p.f. leading. It appears to be most convenient to make a direct comparison between the units on the high-speed lines and those on the low-speed lines.

Of first consideration is the rating of the units in relation to the reactive power requirements. The total reactive demand corresponding to a power factor of 0·9 is 96·82MVAr leading. A general consideration of the design of the high-speed asynchronous generator indicates that it may be expected to have a rating of 100MW at a power factor of 0·75 and will therefore absorb a total reactive power of 88·2MVAr. The net reactive power to be supplied by the synchronous unit will therefore be 8·62MVAr leading, so that this unit will have a rating of 100MW at a leading power factor just removed from unity.

The costs of generators, other factors being equal, may be assumed to vary rather less than the ratio of their D^2L products, where D is the outside diameter and L the length of the core. It will be clear that the generator frame size of the high-speed asynchronous unit rated at 0·75 p.f. leading must be larger than that of the equivalent conventional high-speed synchronous generator rated at 0·9 p.f. leading, and the D^2L ratio is approximately 138 : 100. The low-speed generator rated at about unity p.f. will be somewhat smaller than the conventional generator rated at 0·9 p.f leading, the ratio being approximately 94 : 100. The ratio of the total D^2Ls for the two schemes considered is 232 : 200, an increase of 16 per cent.

On the score of efficiency the larger asynchronous unit on the high-speed line must have relatively larger no-load losses, and as the stator current of this unit is some 20 per cent larger than that of the corresponding synchronous unit, the load losses will be larger. There remains the excitation loss, and although the asynchronous unit has no exciting winding, there is a loss in the rotor surface due to the slip frequency currents ; this loss can be minimised by the use of a squirrel-cage winding. On the other hand, the low-speed synchronous unit rated at a power factor of about unity must have an efficiency at least equal to, if not slightly better than, that of the corresponding unit rated at a power factor of 0·9 leading.

On balance, therefore, there is an increase in the first cost based on the D^2L figures and a slight reduction in efficiency of the asynchronous-synchronous scheme compared with the conventional synchronous arrangement. This additional cost and loss are mitigated to some extent by the less costly construction of the rotor of the asynchronous generator, and must also be offset by savings which may accrue from the reduced cost of switchgear and simplicity of control.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

RAILWAYS INTO ROADWAYS

SIR,—In the article " Railways into Roadways " on page 158 of your issue of January 31, 1958, reference is made to my paper of 1941 on the question of capacity of roads. You will find this matter dealt with more completely and on the basis of present-day conditions in my paper " Working Capacity of Roads " (Part II, *Proceedings of the Instructions of Civil Engineers*, October, 1955).

While under artificial test conditions light vehicles may drive at 60 m.p.h., with a spacing equivalent to a density of 3000 vehicles per hour per lane, not more than 2000 is safe for design purposes at any speed. All the vehicles must then be proceeding at that speed, and no overtaking would be possible.

Let us consider what a headway of 110ft for lorries at 60 m.p.h. would mean in practice. Deducting the length of the lorry, the space is only 80ft—a distance covered in less than one second. In the event of one vehicle having to brake, the driver of the following vehicle, in that one second, has to decide whether the appearance of the stop light means a slight slowing in speed or an emergency stop and then apply his own brake to the same degree. The reaction time for an emergency stop is between 0·4 and 0·8 second, so that such headway gives no practical margin for judgment, for difference in the braking capacity of the vehicles, nor for the fact that the actual head-room between individual vehicles varies widely from the average. Would you, Sir, like to drive a lorry all day under those conditions ?

Railway signal engineers could no doubt say whether a railway could operate forty freight trains per hour at 60 m.p.h., but it is a fact that London Transport normally works forty passenger trains per hour including passenger stops. The terminal facilities, as well as the signalling arrangements, however, have to be of high standard. It would seem to be a mistake for the advocates of turning railways into roadways to base their arguments on such an impossibly high carrying capacity per lane.

A. J. H. CLAYTON

Banstead,
Surrey,
February 21, 1958.

SIR,—I have read the letters of Messrs. England and Ballamy on this subject and in case it has had any practical consideration I feel disposed to ask some questions related to it.

I travel between Sheffield and London fairly frequently by train in about (E. and O.E.) 3¼ hours. Often the conditions are such that I can do useful writing on the way, and then the effective travelling time may come down to zero. With the track converted to a super motor-way, how much reduction below the present 3¼ hours' travelling time could be expected (remembering that some other people may be using the same route at the same time) ? Would there be any chance of approaching the zero effective time that is frequently achieved at present. Or is it thought that the sheer sensuous pleasure of bouncing on rubber and air should reconcile one to longer journey times ? Or is it thought old-fashioned to worry about time at all ? It is wasted in prodigious quantities by individuals driving themselves in motor-cars.

Or is it expected that with developments in telephony, television, tele-smelling and so on, it will be unnecessary for any person to travel at all in the future so that the nation may be free to save millions of pounds per year by using motor-ways to carry (for example) coal 10 tons at a time in 100 m.p.h. motor vehicles ? How many millions of pounds could be saved per year merely by prohibiting parking of vehicles on the existing highways ?

W. A. TUPLIN

Sheffield,
February 21, 1958.

SIR,—With regard to the proposal to convert railways into roadways may I suggest that except where there happen to be four lines abreast British railway tracks are much too narrow to make satisfactory highways.

If anyone doubts this let him go out to Western America and try driving on the roads which have been made out of abandoned railways in the Rockies.

W. B. THOMPSON

London, S.W.1,
February 22, 1958.

SIR,—The advocates of " Conversion of Railways to Roadways " appear to work with one track minds : " more roads," the track that is the cause of more than 6000 deaths, and 30,000 injuries per year.

It should not be lost sight of the fact that our railways in one year (1913) carried no less than 1,454,760,813 passengers, and conveyed 568,201,003 tons of freight, at a cost of only 33 killed and 723 injured. (These figures do not include season ticket holder journeys.)

Observation proves that many road casualties occur not in the narrow congested areas, but on the open fast stretches ; this proves that the control of road vehicles leaves much to be desired, and until really suitable safe methods have been devised, it is safer, and far better to transfer back to the railways, a large proportion of the traffic " filched " away by cut-throat road operators (both passenger and freight), who run their vehicles unfettered by the vast amount of controls " The Board of Trade " impose upon railway operators.

Let us return to sanity, and free the roads of vast numbers of unnecessary long distance freight and passenger vehicles. Use the roads as local feeders only, for passenger and freight traffic. Equip the railheads for quick transfer. We cannot afford the huge road toll of deaths. More roads do not necessarily mean, less slaughter. Rail transport is still the safest, and for many the speediest.

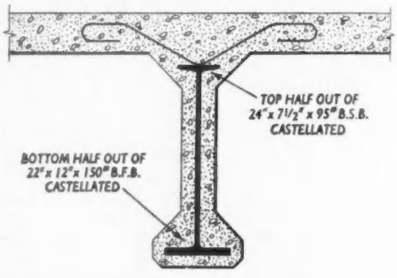
REGINALD B. O. BRINDLE

Wigan,
February 22, 1958.

COMPOSITE STEEL AND CONCRETE CONSTRUCTION

SIR,—Readers of Mr. Wilson's instructive letter in your issue of January 31 may be interested in an analogous application devised as long ago as 1949 for a seaside pier at Deal.

It will be seen from the attached sketch that it was possible to make a virtue out of the necessity for extra fabrication to obtain a heavier bottom flange by adopting castellation of a B.S.B. at the top and a B.F.B. at the bottom. All girders were



encased in concrete and the apertures improved the " bond." Shear connectors were in this case the conventional " hairpins " since only Swiss experience was then readily available.

The project was, in fact, only recently completed,* having been several times postponed. It was estimated that the weight of steelwork was almost halved by adoption of the composite castellated construction as against normal plate girder work.

E. LOEWY

Harrow,
Middlesex,
February 19, 1958.

SIR,—Mr. Wilson's letter in the issue of January 31 on composite construction referred to the full scale tests being carried out at Imperial College. This work has been made possible by the interest and financial support of the British Constructional Steelwork Association. Results will not be made available during the progress of the work, but it is intended to produce a full report in the form of a B.C.S.A. technical bochure when the investigations are complete.

S. R. SPARKES

Imperial College of Science
and Technology,
February 12, 1958.

* See THE ENGINEER, January 10, 1958, page 46.

Book Reviews

British Battleships 1860-1950. By DR. OSCAR PARKES. Seeley, Service and Co., Ltd., 196, Shaftesbury Avenue, London, W.C.2. Price 120s.

THE term battleship (or "capital ship" since the Washington Treaty of 1921) is used to denote the kind of warship which nations requiring to use the high seas must build to fight, on equal terms, the most powerful ship of a potential enemy. Her form and size change, and will continue to change with changes in methods of propulsion and in weapons and equipment. But her role remains unaltered. At the present time Britain and her allies are faced with a potential enemy who would not require to use the ocean routes in time of war and who depends largely on submarines to deny their use to us. His most powerful surface warship is a vessel of the cruiser type. Moreover the aeroplane has replaced the gun as the long range offensive weapon at sea and the aeroplane in turn may soon be replaced by the guided missile and the ballistic rocket. The nuclear reactor is also about to replace the boiler furnace—a revolution in propulsion no less fundamental than the change from wooden ships driven by sail to steam-driven ironclads. It is thus well that Dr. Oscar Parkes—who was for fourteen years joint editor or editor of *Jane's Fighting Ships*—should have written a history of British battleships since the Crimean War. For it was at the end of that war that British warships began to change from sail to steam and from wooden hulls to ironclads. His book, which is dedicated to the Royal Corps of Naval Constructors, is mainly a critical study of the structure, armament and machinery of the long list of ships dealt with, and is of special interest to the naval architect and marine engineer. Dr. Parkes traces the development of the battleship from the laying down in 1859 of Britain's first ironclad, the "Warrior"—a ship of 9200 tons with a horizontal trunk single expansion engine and boilers with a pressure of 20 lb—to the 30-knot "Vanguard," our latest battleship of 44,500 tons, completed in 1946, with a designed horsepower of 130,000. The book also contains brief summaries of the wars at sea and of the principal naval actions during this period of nearly ninety years which should prove very useful for reference.

It is generally accepted that the Royal Navy kept the peace of the world for 100 years after the Napoleonic Wars. But Dr. Parkes makes it abundantly clear that between the beginning of the ironclad era until 1886, when Sir William White became director of naval construction, the Royal Navy maintained peace more as the result of the prestige it had gained than by its own strength and power. During that period of more than twenty-five years the Navy consisted of a medley of large and small armoured ships indicative of the confused and chaotic condition of policy governing design. It was not until 1889 when, with his "Royal Sovereign" design, Sir William—who had been responsible for the formation of the Royal Corps of Naval Constructors six years previously—brought order out of chaos. From then onwards until the all-12in gun "Dreadnought" emerged in 1906, the main batteries of all battleships were placed in armoured positions fore and aft with uninterrupted bow and stern fire and wide arcs of bearing on either beam. During the twenty years previous to Sir William's appointment the chief constructors were first Sir E. J. Reed and subsequently Sir Nathaniel Barnaby and both had to contend with exceptional difficulties from the material and financial aspects of design. The former had to compete with the problems of protection against mines and of the ram—at that time regarded as a primary weapon of offence—and with the rapid increase in gun calibre—which continued even more rapidly during Sir Nathaniel's period of office—from the 12in 35-ton muzzle loader to the 16·25in 110-ton breech loader. Moreover Sir Nathaniel, besides being faced with the new danger of the torpedo, found it almost impossible for armour to keep pace with gun power. Enormous thickness of wrought iron, and later of compound iron and steel, was required to keep out the heaviest projectiles, thus limiting the areas it was possible to protect and complicating the problem of defence along the waterline. Not least of the difficulties was the constant cry from Parliament for economy in the number and size of ships to be built until a war scare or a sudden large foreign building programme created a temporary panic and demands for more and bigger ships.

Since the building of the "Dreadnought," battleship design has undergone no striking change in principle and progress has been in the direction of improvements in gunnery and the manufacture of guns, armour, machinery and boilers rather than in ships' construction. The "Dreadnought" introduced an entirely new idea which has governed battleship building to the present day—an all-big-gun-armament and turbine engines to provide a fast-steaming ship. Mainly due to the splendid efforts of Captain (afterwards Admiral) Sir Perry Scott, there had been a revolution in naval gunnery in the immediately preceding years. Instead of the fighting range of 3000 yards in 1903, it had become clear that decisive results would be possible in the future by salvo firing with a uniform armament of heavy guns at ranges of 10,000 yards and over. The torpedo threat and the consequent necessary increase in battle-range had in fact made the building of the "Dreadnought" inevitable, despite the grave risk of Germany starting her new building programme on equal terms with a new type of ship. The author's chapters on the genesis of the "Dreadnought"—and of our first battlecruiser, the "Invincible"—make extremely interesting reading and clearly illustrate how much we owe to the foresight of the late Admiral Jackie Fisher and his henchman Captain Bacon and to the design work of Mr. Gard, the then construction manager at Portsmouth Dockyard. Dr. Parkes is indeed to be congratulated on completing a most useful work of reference which must have entailed many years of investigation and research.

Personnel Management in the Small Firm. By J. M. COLLINGRIDGE AND M. RITCHIE. Institute of Personnel Management, Management House, 80, Fetter Lane, London, E.C.4. Price 4s. 6d.

IT is surprising that so little has been written about the management of small undertakings, in view of the fact that 95 per cent of all industrial firms in the country employ less than 500 people, or to put it another way, 52 per cent of all industrial workers are engaged in small concerns. Accordingly, the book before us dealing with the management of the personnel in the small firm is particularly welcome. The figure of 500 has been taken arbitrarily to be the outside number of employees in a small firm. In their introductory remarks the authors explain what is meant by personnel management, and what are its aims; after this a chapter is devoted to the significance of personnel management in a small firm, while a third section is devoted to the subject of administration, a brief chapter giving the conclusions arrived at by the authors. There are three useful appendices, the first of which is in the form of a functional chart depicting the different functions involved in the management of personnel, the next sets out the sources of information on the subject, and the third provides three case studies, that of a small multiple retail firm, that of a small firm with no personnel department, and finally that of one employing a personnel officer. Such is a brief outline of the contents of the book.

The small firm has the great advantage of the possibility of close contact between the chief and every member of the organisation, but, nevertheless, it has its pitfalls, for if too much reliance is placed on this contact, serious trouble may result, the bogey of favouritism may creep in, or illness or other causes may render the chief unavailable. Accordingly, we agree with the authors that close contact between management and men should be a good foundation for efficient personnel management rather than its be all and end all.

We are informed that the subject before us falls into six separate groups : employment, training, wages, communications, health and safety, and employee services. While in the large firm it is possible to place each of these functions under its own supervisor, the small firm could not afford so many officials; indeed, there would not be the work to justify them, and we should welcome the authors' opinion as to which functions should be his special province if only one personnel officer can be afforded. In a small engineering works apprenticeship may present difficulties in that it will not be found possible to ensure training in all the necessary branches, but in some cases a solution has been arrived at by arranging interchanges with other small works, to mutual advantage, while much can be gained by organised visits to other works not only by apprentices but also by the staff. With the small firm the need for careful work study is claimed to be as essential as in the large one, but while many employers declare that it is a luxury that is not justified, a case is cited of a factory which only employed 120 and yet appointed a work study officer, with a result that he soon more than paid for his own salary. In the matter of communications it is just as needful to ensure of these being present in the small firm as in the large, yet too often a chief declares that the personal contacts he maintains suffice to ensure the necessary communications; but it has been proved that where periodic meetings, and informal discussions on the company's policy, the nature of orders, new ventures, &c., have been held, the labour turnover has decreased, while even small businesses have found it possible to issue a magazine. While the authors evidently prefer functional organisation to line management, we should like to have seen them insist on an operator being responsible to one chief only, for "no servant can serve two masters."

In their conclusions the authors wisely say that they "cannot over-stress the diversity of the small firm. There is no one answer to its problems : whatever the personnel policy, administration and practice adopted, it must be tailor-made to suit the particular company." The broad principles outlined in this book and the suggestions made, are, however, applicable to most small undertakings, and the numerous ex-

amples interspersed in the text, should all prove helpful to those in charge of small firms to whom this book can safely be recommended.

Wirkungsgrad und Selbsthemmung einfacher Umlaufgetriebe (Efficiency and Irreversibility of Simple Epicyclic Gear Trains). By BENGT CARLSSON and HANS LARSSON. Report No. 1 from the Institut for Machine Elements, Chalmers Technical University. Elanders Boktryckeri Aktiebolag, Göteborg Price 9 Kronor.

THE report contains a theoretical investigation of the efficiency and irreversibility of simple epicyclic gear trains in which all three members are rotating. The case with one non-rotating member which has often been treated by other authors, is included in the graphs as a special case. These graphs give the efficiencies between 50 and 95 per cent as functions of parameters involving the speeds of revolution of the component gears. The irreversible region is clearly shown on the graphs. It is found that irreversible epicyclic trains can have efficiencies higher than 0·50. An appendix contains a detailed treatment of the Wolfrom gear train.

Les Aciers de Fabrication Française. By MAURICE PELOU. Editions Science et Industrie, 6, Avenue Pierre-1er de Serbie, Paris (16e). Price 1500 francs.

THE present sixth edition of "Steels of French Manufacture"—the book first appeared twenty years ago and the previous edition dates from 1952—has been modified and extended in many ways. One of the principal changes is due to the fusion of several steel plants which has taken place and which made it necessary to make corresponding changes in the numbering of the steel grades. Secondly, steels equivalent to foreign products are specially marked as such. In some cases, the multiplication of grades has made it necessary to split some tables into two parts. Other changes are due to progress with stainless and heat resisting steels, and the introduction of material with new magnetic properties, notably special magnetic alloys, and magnetically oriented sheet. Comparison of the classifications with various French and foreign standards is given in an appendix.

Technical Reports

Specification for Road and Bridge Works. H.M. Stationery Office. Price 5s.—A revised edition of the Ministry of Transport and Civil Aviation's *Specification for Road and Bridge Works* has now been published. A number of the original road works clauses remain unaltered, but many others have been either subdivided, recast or, in a few cases, omitted. New clauses have been included where necessary, mostly in connection with methods of construction which have become more firmly established in recent years. Amongst these various changes attention is drawn particularly to the inclusion of lean concrete granular base (clause 806), premixed waterbound macadam base (clause 807), the use of soil cement both as a base and a sub-base (clauses 810 and 804), and dense tar surfacing (clause 907). Attention has also been given to bringing the clauses relating to concrete carriageway construction up to date as this is a subject on which research and experiment has progressed rapidly since 1951.

For the present, the bridge works clauses remain unchanged from the 1951 edition, but it is hoped to undertake their revision in the near future. A supplementary document, *Notes on the Specification for Road and Bridge Works and on the Preparation of Bills of Quantities*, is in preparation.

Investigations on an Experimental Air-Cooled Turbine. Part I: General Description of Turbine and Experimental Technique. By D. G. Ainley and N. E. Waldren. *Part II: Cooling Characteristics of Blades Having a Multiplicity of Small Diameter Coolant Passages.* By D. G. Ainley, N. E. Waldren and K. Hughes. Reports and Memoranda No. 2975. H.M. Stationery Office. Price 18s.—Tests on internally air-cooled turbine blades operating under realistic conditions are required to determine (*a*) the degree of cooling achievable, and (*b*) the effects of cooling on the overall turbine performance. This requirement has led to the manufacture and installation of an experimental air-cooled turbine specially designed for testing internally air-cooled nozzle and rotor blades. The first part of the report records a general description of the turbine, the first set of cooled blades to be tested, and the associated instrumentation. It also records some results of early tests made to check the cooling of the turbine structure (excluding blades).

A thorough examination in the experimental turbine of the cooling characteristics of a set of internally air-cooled nozzle and rotor blades is described in Part II. Particular attention was paid to the rotor blade cooling characteristics and results show that a very substantial reduction in mean rotor blade temperature may be achieved with a cooling flow equal to 2 per cent of the main gas flow. The blades were not uniformly cooled, the blade temperatures being very much higher near the leading and trailing edges than in the mid-chord sections. However, examination of the steady thermal stresses created by the non-uniformity in cooling, and the transient stresses likely to occur during "thermal shock," suggest that the non-uniform cooling is not very detrimental. An increase in turbine inlet gas temperature of about 270 deg. Cent. above the permissible value for the same rotor blades and same life without cooling appears possible with a cooling flow ratio of 0·02. The results further indicate that when operating with a fixed cooling flow ratio the mean degree of cooling achieved on the present blades is not substantially influenced by changes in the gas flow Reynolds number, or, within limits, by substantial changes in blade aerodynamic loading. The results also indicate that cascade tests to investigate cooling characteristics of blades may not be wholly applicable to similar blades operating in an actual turbine stage. This may be due largely to the fact that the amount of heat transferred from the gas to a blade is influenced considerably by the location of the boundary-layer transition points and these, in turn, may be greatly influenced by the degree and nature of the turbulence in the main gas stream.

Instability in a Slotted Wall Tunnel. By J. L. King, P. Boyle and J. B. Ogle. A.R.C. Current Paper No. 343. H.M.Stationery Office. Price 4s.—Large pressure fluctuations have been observed in the working section of A.R.L.'s new 30in water tunnel. The present report describes investigations carried out in a 7in wind tunnel to examine such fluctuations in detail, and also theoretical investigations which explain and describe the phenomena.

It is shown theoretically that a jet of fluid circular in cross-section moving through the same fluid is unstable. The slotted wall is unable to stabilise all frequencies of disturbance. The length of the working section determines preferred wavelengths of disturbance which feed energy back to the upstream end of the jet by compressing the fluid in the reservoir surrounding the working section. In the absence of a reservoir the instability disappears.

The present report is not concerned with the performance of the 30in tunnel or with measures now being taken to improve it.

Direct Stress Fatigue Tests on Redux-Bonded and Riveted Double Strap Joints in 10 S.W.G. Aluminium Alloy Sheet. By S. Kelsey and J. B. Spooner. A.R.C. Current Paper No. 353. H.M. Stationery Office. Price 6s. 6d.—Tensile fatigue tests were carried out on sheet specimens in D.T.D. 610B, 546B and 687A, with double-strap Redux and riveted joints. Bonded joints tended to fail by shear of the bond at the higher stress ranges and by tension of the sheet at the lower stress ranges. Riveted joints failed by tension across the first row of rivets in all cases, though tests on three-row riveted joints showed considerable improvement in endurance over those with two rows of rivets. Endurances were greater for bonded joints but with rather more scatter than for riveted joints, particularly where bond shear was the cause of failure.

Books of Reference

Kempe's Engineers Year Book. Sixty-third edition. 1958. Morgan Brothers (Publishers), Ltd., 28, Essex Street, London, W.C.2. Price 82s. 6d.—It may be that there was a time in the distant past when the publishers of *Kempe's Engineers Year Book*, that mine of information upon every engineering subject, could send out a new edition little changed from that which preceded it the year before. But engineering advances are quicker now. Thus, year by year, in reviewing the *Year Book*, it falls to us to record how this section or that has been wholly revised, other sections heavily rewritten, and still others brought, here and there, in a page or two, or in a line or two, up to date. This year we see from the preface the usual long list of new material that has been incorporated. What, of course, is less realised by the user is the care with which dead-wood is cut out. For it would be fatally easy in such a volume, covering so very wide a field, to incorporate the new without extinguishing the old, leading to the confusion of the user and a steady, but increasing, growth in the size of the volume. Out of curiosity upon that point, as we were writing this review, we picked up *Kempe's* for the year 1932. That volume just happened to be handy. It contains over 2900 pages. Yet, despite all that has happened in over a quarter of a century, all the new developments in nuclear power, electronics and gas turbines not to speak of advances in many other fields, the 1958 volume contains only just over 2600 pages, in clearer type. It now covers a wider field more successfully and more conveniently for the user in 300 fewer pages!

We refer throughout to the user of *Kempe's* rather than to the reader. It is, of course, abundantly true that the various sections of *Kempe's* are well worth reading. But the true value of the work has been, and remains, that of reference. With *Kempe's* on the shelf behind him, an engineer at his desk can feel certain of up-to-date and accurate instruction upon any facet of engineering about which he may be asked for or need information. It is there, too, readily to confirm a figure or an equation should he feel uncertain. In miniature, it is a whole engineering library. True, it cannot compete in exhaustiveness with well-stocked library shelves. But how much quicker it often proves to reach it down and consult it than to find just the right book from the library! And who, as an individual, could afford to collect and maintain a complete library covering so wide a field? Much could be forgiven in such a volume. In fact, as regular users ourselves, we know how difficult it is to find it at fault. Its editor and all those who contribute to it are once again to be congratulated upon the production of a new edition.

Fasteners Handbook. By J. Soled. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 100s.—This handbook covers a majority of the many and varied designs of screws, bolts, nuts and other types of fasteners made in the United States, a number of which are available in this country. It is basically a detailed and illustrated classified catalogue of the products of a large number of manufacturers. Each design of fastener is clearly illustrated and its construction described with notes on its particular properties, uses, standard sizes available and the name of its manufacturer. Brief particulars are also given of American standard screws, bolts, nuts and fastenings, with the numbers of the relevant specifications. By providing an easy reference, this book enables designers and engineers to select the most suitable form of fastener for particular requirements without having to search through numerous catalogues.

Books Received

Electrical Year Book 1958. Emmot and Co., Ltd., 31, King Street West, Manchester 3. Price 3s. 6d.

Mechanical World Year Book, 1958. Emmot and Co., Ltd., 31, King Street West, Manchester, 3. Price 4s. 6d.

Lehrbriefe für Kaltetechnik. Edited by Professor H. Weimar. Verlag C. F. Müller, Karlsruhe, Germany. Price DM.7.70.

Welding Handbook. Book I. Fourth Edition. Edited by A. L. Phillips. Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 72s.

Statically-Indeterminate Structures. Third Edition. By R. Garner. Concrete Publications, Ltd., 14, Dartmouth Street, Westminster, S.W.1. Price 18s.

Soviet Education for Science and Technology. By A. G. Korol. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 68s.

Structural Engineers Data Book. By D. A. Cresswell and J. H. King. Sir Isaac Pitman and Sons, Pitman House, Parker Street, Kingsway, W.C.2. Price 35s.

Proceedings of the Fifth Midwestern Conference on Fluid Mechanics. Edited by A. M. Kuethe. The University of Michigan Press, Michigan, U.S.A. Price 8 dollars.

Hydro-Electric Engineering Practice. Volume I. Civil Engineering. Edited by J. Guthrie Brown. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 189s.

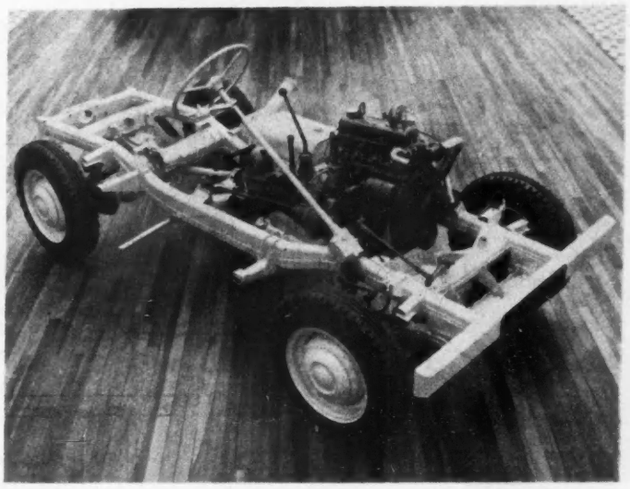
Hydro-Electric Engineering Practice. Volume II. Mechanical and Electrical Engineering. Edited by J. Guthrie Brown. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 126s.

Hydro-Electric Engineering Practice. Volume III. Economics, Operation and Maintenance. Edited by J. Guthrie Brown. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 84s.

Surface Energy of Solids. By V. D. Kuznetsov. Translated from Russian. Department of Scientific and Industrial Research, Charles House, 5-11, Regent Street, London, S.W.1. Price 8s. 6d. from H.M. Stationery Office.

Simplified Suspension

A vehicle in which each wheel is located in all directions by a single annular rubber spring, and in addition driven by a shaft and Hooke's couplings, is called the "Gipsy." It differs from its predecessors, which were primarily for use by the fighting services, in that it is not intended for sustained driving across country, there being many exposed universal joints and grease nipples: rather it is for high speed and comfortable travel on unimproved roads, with the ability to negotiate the stretches of poor traction or high resistance associated with such roads.



WE recently attended a demonstration of the Austin "Gipsy" 4 by 4 ½-ton utility vehicle. It is distinguished by its system of suspension, which uses "Flexitor" rubber-in-shear springs to locate the wheels both in the vertical direction and the horizontal plane. The simplification possible with such a system has been carried to the extreme of using only one trailing arm to carry even the steering wheels, a practice hitherto confined, we believe, to front-wheel-drive vehicles. The rubber is stressed very slightly in order to ensure a long and predictable life in service (as a result life is anticipated to be of the order of fifteen years, regardless of utilisation, but for obvious reasons this has not been verified): consequently the spring rate is uniform with deflection, and a progressive action is obtained by bump stops which change their contour with travel. In view of the novelty of this suspension, which has previously been used on trailing wheels only, we shall record our impressions of the behaviour of the vehicle before describing it in any detail.

The suspension is, for normal motoring, hard: this is inevitable with the simple geometry employed. On irregular surfaces there is very little tendency for a synchronous pounding of the wheels to commence, and sharp-edged irregularities of amplitudes of about 6in can be surmounted without any discomfort at, say, 30 m.p.h. when driving in a straight line. Very large, abrupt bumps or hollows naturally disturb the vehicle and speed is limited by the difficulty of keeping on course: "crash through" of the suspension is seldom or never evident. On soft surfaces there is, of course, no consistent tendency to spin one wheel only. We have not been able to try the "washboard" surface associated with graded roads.

The handling characteristics are, naturally, unusual, but beyond description on the basis of a very short drive on a rough road. At moderate speeds on a hard surface, the steering self-centres strongly, feeling as if dominated by the heavy king pin inclination. When unloaded, the vehicle is highly stable directionally. The steering is low-geared, and large control movements are needed to generate a rapid response. On bad surfaces the low ratio isolates the driver from any sharp impulses at the front wheels, and very little strength is needed to keep the vehicle under control. On loose surfaces of sand or gravel, however, where large steering deflections and even larger corrections may be necessary to hold a curved course, the vehicle performance is limited by the speed at which the steering wheel can be turned through large angles.

We are advised by the engineers responsible for the vehicle that, while the handling qualities are quite unusual, the low unsprung weight and large tyres result in a cornering power, at the speeds of which the vehicle is capable, inferior to no other Austin car.

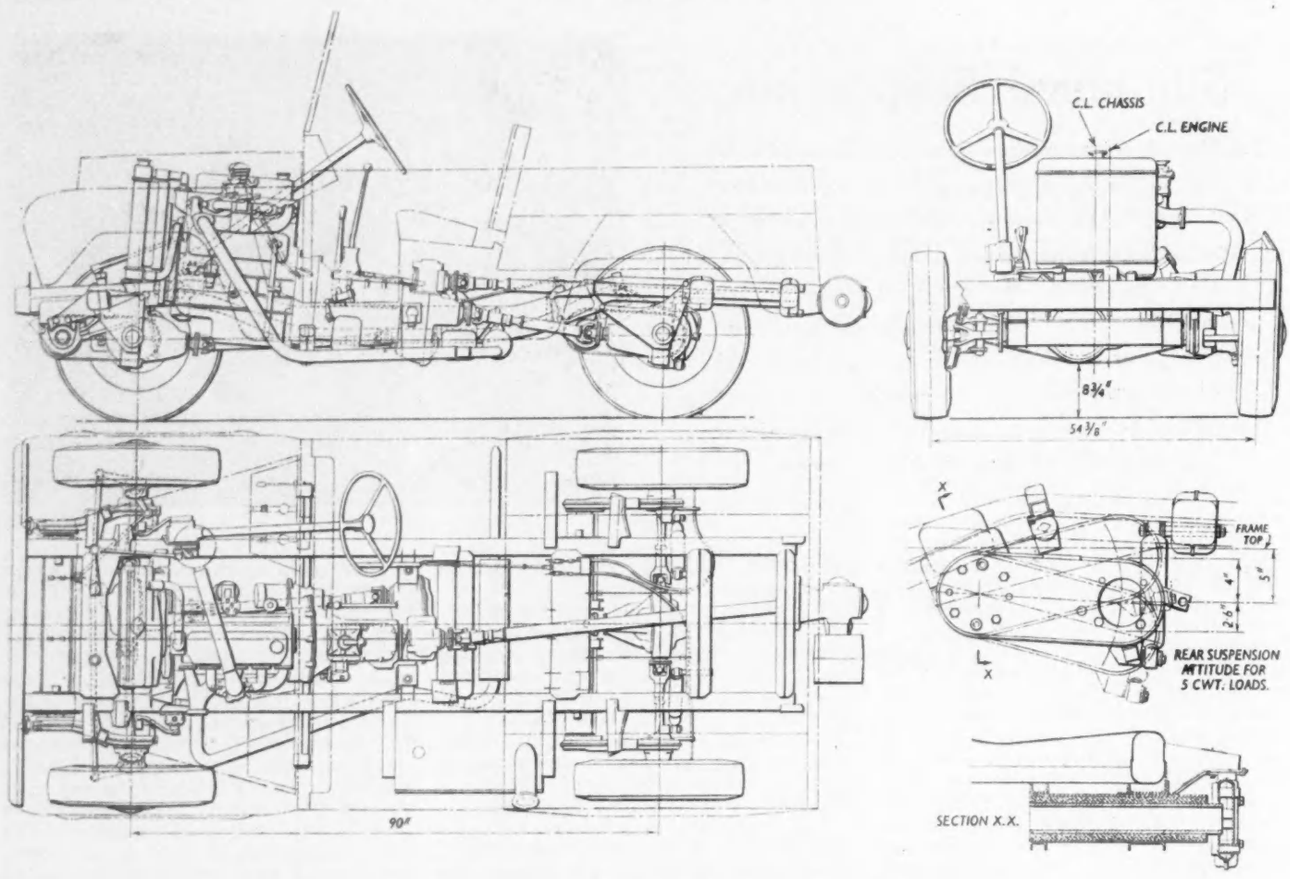
The general arrangement of the vehicle can be discerned in the accompanying drawings: a large proportion of conventional automobile components are employed.

The engine can be either of the units standard in the Austin taxi, i.e. the "A.70" petrol engine or the 2·2-litre diesel: the gross outputs and dry vehicle weights are, respectively, 62 b.h.p. at 4100 r.p.m. in 24 cwt., and 55 b.h.p. at 3500 r.p.m. in 25¼ cwt. The driving characteristics of the two variants are likely to be very different, the petrol engine having a maximum torque of 110 lb-ft at 1500 r.p.m. and the oil engine 89 lb-ft at 2800 r.p.m.: the diesel will presumably be recommended for applications involving large road mileages. The power units are not water-proofed or otherwise adapted for cross-country work. The engines may be run at inclinations of 20 deg. to the horizontal about any axis indefinitely, and at 30 deg. for up to 30 seconds. The diesel engine demonstrated to us was praiseworthily quiet, bearing in mind that the cylinder block was immediately beyond the cockpit bulkhead, and idled very steadily and slowly on its pneumatic governor. It did appear that, in a bonnet opening only at the top, access to the fuel pump and the high-tension distributor would be difficult: there is no sludge drain on the fuel lift pump, nor is there a separate fuel filter or water trap. The last stage in the throttle linkage is, on the petrol engine, a torsion bar, thus isolating the controls from translational movements of the power unit on its mountings: the throttle opens with an anti-clockwise motion, so that feedback is positive. A normal clutch with spring centre is fitted, 9in in diameter for the petrol engine, and 10in for the diesel which will call for more gear changing.

The main gearbox is also that in use on the taxi, with four speeds and reverse, synchromesh being provided on the upper three ratios. A tyre pump can be driven off this box. To its output end is attached a coventional layshaft auxiliary reduction with a ratio of 2·02: the second stage of gears drives the front axle and, if required, the full torque power take off. All gears are helical and in constant mesh, engagements being made by toothed couplings similar to those in a synchromesh box, although synchromesh is not embodied: a single movement of the lever engages both front wheel drive and low ratio, and hence changes are specified to be made at a standstill.

The differential carriers are common to the beam axle A.90 and A.95 cars, but the pressed housings are of course special to the "Gipsy." The hypoid bevel gears are also special to this chassis, having a ratio of 5·125. The final drives are identical front and rear: the opposite rotation of the gears at the front is not considered significant. The maximum tractive effort available is 3000 lb, so that on a hard surface adhesion is the only limit to the gradient ability. The power is delivered to the stub axles by conventional Hardy Spicer shafts with splined sliding joints between the couplings: there are three lubrication nipples on each shaft, and the first vehicles to enter service will require them to be lubricated at 1000-mile intervals. On the assumption that four wheel drive will be engaged only on surfaces not affording good traction, constant velocity joints have not been employed at the front: the joints between the king pin pivots are protected from foreign matter to some extent by being inside the large hollow hubs, but can be seen and lubricated when the steering is on full lock.

The chassis, though classical in conception, is distinctive in detail design. All the principal members are welded up into tubular sections, the cross-members consisting of two top-hat—or rather bowler hat—pressings welded together through the brims. The longitudinals, however, consist of a pair of U sections with the open end of one fitting into the open end of the other: the advantage claimed for this section is that the parts most highly stressed under torsion, i.e. the radiused corners, have been strengthened by cold working in the forming of the U. The seams of the tube are at the sides, and since the side members are straight in plan view, this has allowed the blanks to be cut from parallel strip: the more conventional approach of using seams at top and bottom would have involved a great waste of metal in cutting irregularly shaped blanks. The cross-members total six, but the second one, immediately below the clutch, is smaller in section than the remainder: it passes below rather than between the longitudinals and is fitted principally to support the body. Since it obstructs the removal and replacement of power unit or transmission when the body is in place, it is hoped that it may prove possible to carry the body on cantilevers from the main side members. The



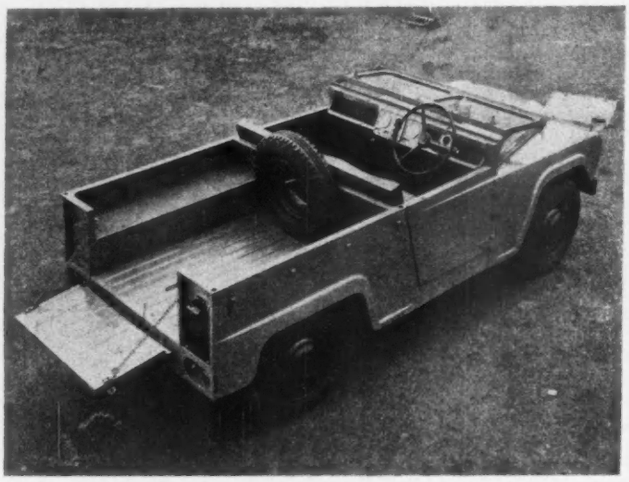
General arrangement of "Gipsy" 10 cwt vehicle

rearmost cross-member has provision for a towing hook and is therefore rendered stable as a beam by including a flat web at right angles to the plane of the seams : slots are punched in the two troughs and tongues on the web enter them, being burnt off after the halves are welded together. All major welds are performed automatically in the works of the chassis suppliers, John Thompson, Ltd.

Forming the first and under the fourth cross-members are the springs. These are supplied by the Avon India Rubber Company ; each spring consists of a central tube and a trough-shaped member, between which a mass of rubber is bonded. The top of the trough is then closed by a top plate which is spot welded between the upper edges of the trough, and in fitting the top plate the rubber is given an initial compression which, we are advised, contributes materially to its fatigue resistance. The upper edges of the trough are the principal locating faces of the spring unit. The characteristics of the "Flexitor" units on the "Gipsy" are given in the accompanying table.

	Front	Rear
Approximate loading per unit (laden)	730 lb	940 lb
Approximate periodicity (F_N)	115 cpm	125 cpm
Axial stiffness	18,000 lb per inch	22,000 lb per inch
Radial stiffness	140,000 lb per inch	156,000 lb per inch
Resistance to tilting of axis	40,000 lb per inch per deg.	56,000 lb per inch per deg.
Deflection (normal loading)	¼ deg.	½ deg.

We understand that, for a given design stress, and hence life, the axial and radial stiffnesses can be increased, for a given deflection characteristic, by increasing the length of the spring unit. The internal damping of these springs is significant, but the heat evolved is not sufficient to damage the rubber in any natural environment : it is interesting to note that although the suspension will be extremely hard after the vehicle has been left to stand in an arctic temperature, the internal damping will nevertheless quite soon restore the rubber to normal. There is a transient yield of the springs after long exposure to tropical heat : no harm is done to the rubber by using it in this state, however.



On the right-hand drive "Gipsy" the lever nearest the driver controls the transfer box and the longer lever the main gearbox ; the hand brake is beneath his left thigh

Bolted directly to the ends of the suspension units are the trailing arms : the production springs have the unloaded attitude controlled, between abutments and mounting holes, within $^1/_{20}$ deg, so that no adjustment is regarded as necessary. The amount of the small initial settlement is also consistent. The rear suspension design is very simple, each arm consisting of a pair of shallow flanged pressings welded together around their periphery to form a hollow box : brackets for the telescopic shock absorber and the hand-brake "Bowdenex" cable abutment are added at the rear. To provide a smooth surface for the progressive bump stop, a small platform is welded on above the seam along the top edge of the arm. Since B.M.C. live axles are semi-floating, the design of the hub and carrier do not differ fundamentally from their normal practice.

The design of the front suspension is, of course, considerably more intricate, although the main components, the trailing arms, appear similar. Platforms for the bump stops are again added to the top edges, but lever-pattern hydraulic dampers are fitted, with a rubber ball joint at the bottom of the link and, since the lever travel is very large, a cylindrical bush at the top. With the high suspension frequency characteristic of this vehicle, it was found that the attitude of the front pair of trailing arms altered only 1 deg. between laden and unladen, and it was decided that such a change

in the caster angle, normally 3 deg., would be acceptable. The differential change in caster with roll appears to act in such a direction as to reduce self-righting torque, but this effect is both held down by the hard suspension, despite the ground-level roll axis, and obscured by the very high king pin inclination. The king pin inclination is 12 deg., and there is also a lateral offset of 1¼in (for 5·00 by 16 wheel with 6·00 tyre), between the centre of the contact area and the king pin axis. With a single trailing arm geometry it is theoretically possible, even as on a Dubonnet suspension, to use a single track rod, but the rod must pass along the axis of the trailing arms. On the "Gipsy" a track rod passing through apertures in the trailing arms near the middle of their length is used, the ball joints being within the wheel rims. The end of the drag link lies rather closer to the suspension axis, on the end of a deep bell crank which can be fitted at either side of the chassis depending on the driver's position. A steering box of the worm and peg pattern, for which the transmission efficiency is not particularly high, has been selected : the ratio is 14·5. All the steering connections are ball and socket joints of "Nylon." The king pins have plain bearings, with grease nipples at the ends of the pins, and the thrust washer is of sintered bronze so that friction will not be absent from the swivels. Since the camber changes are effectively the same at front and rear, the tyre pressures differ markedly (front 20 lb per square inch, rear 26 lb per square inch) to give positive static stability.

The body, which is essentially unstressed, is made of steel, in order that any damage can be repaired by welding The body is phosphate treated before painting in the same manner as Austin car bodies ; since both sides of every panel are exposed, repair of any areas that are corroded should not present undue difficulty. The cockpit has seats for three persons, but the gearbox cowling occupies the space required for the feet of a normal sized person in the centre : the left hand drive versions, in which the gear lever is close to the driver, may be preferable in this respect. The doors can be lifted off their hinges : the catches holding them on to their locating pegs are operated by cables across the inner surface near the top. The long wheel arches each include two lockers, secured by small cowling fasteners with wire handles, or can be upholstered to afford seats for six persons.

The controls include large pedals, requiring little effort, for clutch and brake : these operate hydraulic master cylinders, thus allowing the integrity of the floor to be preserved. The throttle control is a small, isolated pedal, and, at least on rough going, it would be an advantage if there were a treadle upon which the driver could bear hard. The windscreen wiper is on the bottom of the screen and tempts the driver to reach through the wheel to control it.

A fuel tank of 13 gallons capacity is claimed to afford a range of 325 miles on petrol and 420 miles on fuel oil. The fuel piping is of "Nylon," sufficiently transparent for bubbles to be seen in a clean pipe, and supported by passing through sections of tube about 2in long welded to the chassis.

Equipment which may be specified includes a capstan located in front of the radiator, driven by a dog clutch off the front end of the crankshaft. When the power take-off is to be used continuously, an oil radiator of gilled tube construction can be specified. A towing hook and a socket for trailer electrical connections, excluding electric braking, are also optional.

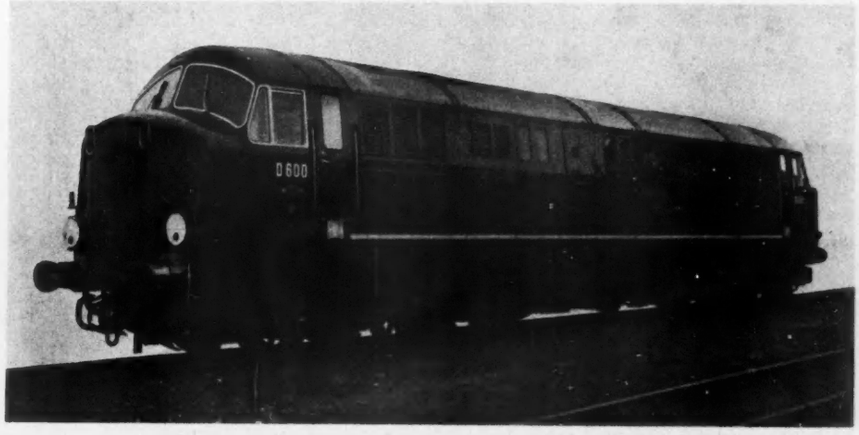
2000 H.P. Diesel Hydraulic Locomotive

Under the railway modernisation plans it is proposed to replace steam locomotives completely by diesel traction on the whole of the Western Region lines between Newton Abbot and Penzance, and initially on many through trains between Paddington and Bristol and the west of England. Under this programme about 130 *diesel hydraulic main line locomotives will replace* 200 *steam locomotives. In a demonstration run on Monday last of the first* 2000 *h.p. diesel hydraulic locomotive to be delivered a nine-coach train was hauled from Paddington to Bristol and back.*

DETAILS have now been released of the first of the five A–1–A A–1–A diesel hydraulic locomotives of 2000 h.p. being built by the North British Locomotive Company, Ltd., for service on the Western Region of British Railways. This type 4 locomotive, numbered D600 and named "Active," is illustrated on this page and its leading particulars are given in the table we reproduce. It is powered by two N.B.L.-M.A.N. pressure-charged, twelve cylinder diesel engines, each with a rated output of 1000 b.h.p. at 1445 r.p.m. or 1100 b.h.p. at 1500 r.p.m. Each engine drives the outer axles of one bogie through a Voith/North British "L306r" hydraulic transmission equipment with a maximum rating of 925 h.p. at 1445 r.p.m. input and 1036 h.p. at 1500 r.p.m. input.

Leading Particulars of Diesel Hydraulic Locomotive No. D600

Length over buffers	65ft
Bogie wheelbase	15ft
Driving wheel diameter	3ft 7in
Carrying wheel diameter	3ft 3½in
Weight in working order	117 tons 8 cwt
Fuel capacity	800 gallons
Water capacity	1000 gallons
Maximum speed	90 m.p.h.
Maximum tractive effort (30 per cent adhesion) and continuous rating	50,000 lb



2000 h.p. diesel hydraulic locomotive for Western Region of British Railways

The locomotive has a main frame built of mild steel plates and sections, the main longitudinal members being built up to form an I-section and braced by cross stretchers. This framework is completed by plates and channels and on top of it a platform is built to form a continuous floor. Standard side buffers and drawgear are fitted at each end of the locomotive, together with connections for the carriage warming and the vacuum train pipe systems. The nose at each end of the locomotive is fitted with doors to give through access when locomotives are arranged for multi-unit operation, and jumper sockets are provided for coupling and remote control.

The double-plate six-wheeled bogies have welded and stress relieved sub-assemblies. The traction, braking and transverse forces are taken by an inner and outer centring ring, the inner part of the ring being attached to the underframe and the outer part being integral with the bolster. Four widely spaced bearing pads which rest on a double swing link bolster take the total weight of the main frame and superstructure. This bolster in turn rests on the transverse laminated springs supported from the bogie frames by spring link planks and swing links. From the bogie frame the load is transferred to the grease-lubricated Timken roller-bearing axleboxes by a system of beams and coil springs. Manganese steel liners are fitted on axlebox and hornface guides.

Engines and Transmission

The two N.B.L.-M.A.N. "L12V 18/21S" twelve-cylinder engines are each pressure charged by Napier exhaust gas turbo-blowers. The engines are mounted on bedplates which are flexibly mounted on the underframe. Connection of the engine shaft to its transmission is through Hardy Spicer cardan shaft. The cylinder banks are set at 60 deg. with the cylinders staggered to allow for side-by-side connecting-rods on each crank. The wet cylinder liners, of cast iron, are located in place by individual cast iron cylinder heads and are free to expand downwards by rubber sealing rings fitted at the lower end. The crankcase is of a fabricated steel construction incorporating seven cast steel bulkheads carrying the main bearing housings. The two cylinder blocks welded to the main crankcase frame are constructed from formed steel plates. The cylinder banks are joined at the top by a steel platform which carries the monobloc fuel pumps and governor. To relieve the

stresses set up in the cylinder blocks, tie bolts are fitted and extend from the top of the blocks into the cast steel bulkheads. The crankshaft is made from alloy steel forging hardened and ground, the crank webs being drilled to allow an oil flow from the main bearings to the crankpin bearings. Cylinder heads are each fitted with two inlet and two exhaust valves, a fuel injector and a precombustion chamber.

The valves on each cylinder bank are operated by a camshaft which is situated between the two banks and positively driven by spur gearwheel. A gear drive to the tandem fuel pumps is taken from the free end of the camshaft. The connecting-rods are one-piece forgings of alloy steel with a copper/lead steel-backed bearing at the large end and a phosphor-bronze bush at the small end. Oil is carried from the big end to the small end by a centrally drilled oil hole.

Exhaust manifolds from the engine connect with the Napier pressure charger inlet, and the output from the pressure charger is ducted through the roof. The hydraulically boosted governor is gear driven from the crankshaft and an electro-pneumatic remote control gear gives seven speed steps from idling to full load. Engine lubrication is primed from a pump driven by an electric motor which cuts out when the engine starts as the oil pressure switch closes and operates the dynostarter motor contactor.

Each of the two sets of hydraulic transmission equipment is connected through a Hardy Spicer cardan shaft to its appropriate diesel engine. In each transmission there are three torque converters. Infinitely variable torque multiplication is inherent in the design of each hydraulic torque converter, but in this installation one is designed to be the most efficient at starting and low speeds, the next for intermediate speeds and the third for high speeds. One converter is filled as another is emptied and the change is made without interruption to the transmission of torque to the wheels. Transmission oil is cooled in a heat exchanger, where the heat is transferred to the engine cooling water. This method is designed to ensure rapid warming up to the best operating temperature and prevent excessive temperature rise even under severe overloads. Reverse gears are built into the transmissions, the direction of change being controlled by electro-pneumatic valves. A safety device prevents the driver reversing the locomotive while it is still in motion.

Drive from each hydraulic transmission to the axle-mounted gearboxes on the outer axles of each bogie is through Hardy Spicer cardan shafts fitted with needle-bearing universal joints. The gearboxes on each bogie have spiral bevel reduction gears and the reaction torque from each gearbox is taken through torque arms and rubber bushes to the bogie frame. These axleboxes were supplied by David Brown (Huddersfield), Ltd. Each engine and transmission unit is independent of the other and can be cut out if required.

The dynostarter on each engine is driven directly from the engine crankshaft and when acting as a generator provides 110V for supplying the electrical load and charging the battery. The voltage is automatically held within fine limits irrespective of the generator speed. When acting as a starter the starting current is drawn from a forty-eight cell lead acid battery of ample capacity. The two dynostarters were supplied by the Electric Construction Company, Ltd.

The cooling fan motors of the Serck radiators of the engines are controlled by the water outlet temperatures from the engines. When the water temperature of an engine reaches 180 deg. Fah. the fan is automatically switched on and temperature is controlled by a Drayton regulator. When the temperature drops to 170 deg. Fah. the fan motor is switched off.

Individual motor-driven exhausters and compressors are provided for the braking equipment, and four brake cylinders on each bogie operate clasp brakes on each wheel. A Westinghouse vacuum-controlled straight air brake is fitted on the locomotive and the driver's vacuum brake valve applies the train brake and makes a proportional application of the locomotive air brakes. Operation of the air brake handle does not affect the train, but makes a straight air application on the locomotive, or on all the locomotives in a multiple unit. In the unoccupied cab or cabs the air brake handle is in the "release" position and the vacuum brake handle in the "running" position. When hauling an unbraked or partially braked train the brake application on the locomotive must be controlled by the three-chamber reservoir unit. The operation of the vacuum emergency valve must be delayed until that application is completed, and this is accomplished by introducing into the supply pipe to the vacuum emergency valve a "train-braked/train-unbraked" change-over cock and a timing reservoir. A fly-handle on the driver's air brake cuts out the proportional application and allows the locomotive to be moved, even if the train pipe vacuum is broken.

The photograph we reproduce of the driver's cab shows the way in which the control pedestal has been arranged on the left of the driver.

The controls are grouped together in each cab. At the first step of the power handle the engine idles, but no power is transmitted, since the filling valve of each transmission is in the closed position, allowing no oil to the first torque converter. At the next step the filling valve of each transmission opens and power is transmitted to the wheels. The remaining steps give progressively greater engine speeds and greater power to the wheels up to the maximum. When the master reversing handle is at the "off" position, all controls are dead and this handle is locked in the "off" position when the master key is removed. Interlocks prevent incorrect operation of the reverse gears and the application of power unless the gears in all transmissions are home in the correct direction.

Separate start and stop buttons allow either engine to be cut in or out at will. As is usual, automatic safeguards are provided to protect the engines and transmissions against excessive oil temperatures, and the engines against loss of oil pressure, loss of water or excessive overspeed. Remote-reading tachometers indicate to the driver the speeds of any engine, when in single or in multiple locomotive working. A Spanner train heating boiler situated at the centre of the locomotive has a working pressure of 80 lb per square inch and its water is maintained at the correct working level by a regulator.

In addition to these five 2000 h.p. locomotives, the North British Locomotive Company, Ltd., has orders for a further fifty-eight 1000 h.p. B–B diesel hydraulic locomotives. Thirty-three diesel hydraulic locomotives being built at the Swindon works of the Western Region are of 2000 h.p. with a B–B wheel arrangement, and these locomotives have Maybach engines with Mekydro transmission. Orders have yet to be placed for the remaining thirty-four locomotives of 2000 h.p., which are required under the present programme of conversion from steam to diesel traction in the Western Region.

View through cab door of diesel hydraulic locomotive showing driver's control pedestal

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

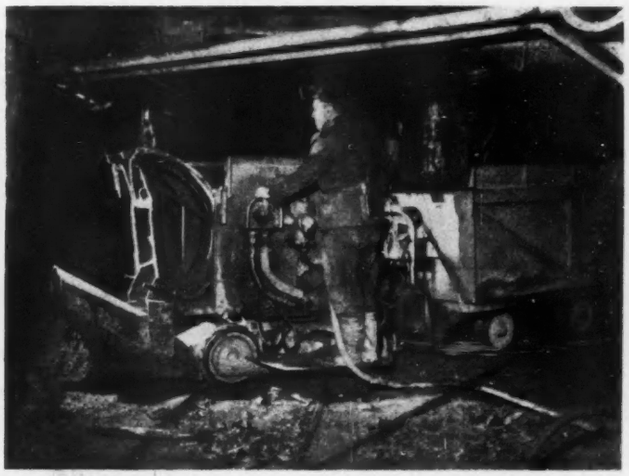
SCHEDULE OF COPPER AND COPPER ALLOY TUBES

No. 2871 : 1957. Price 15s. This schedule is the first of a series to be prepared for copper and copper alloys in various wrought forms. It contains all the requirements from existing standards for copper and copper alloy tubes, with adequate cross references to the individual standards, which will for the present continue to exist. The new standard also contains requirements for six alloys not previously included in standards for tubes.

The general requirements applicable to all materials are grouped in the first section, together with the relevant tolerances; and the specific requirements for each of seventeen materials are dealt with in the next section. These requirements include the chemical composition (with cross references to the existing standards in which the chemical compositions appear), the conditions in which the material is available, and the mechanical properties. Materials are identified by symbols, which in future schedules for wrought products will be used for the same alloys wherever they appear. The same symbols will be introduced into the existing British Standards when they are revised.

The requirements included in these first two sections apply to the materials when they are required for general purposes. Many of the existing individual standards, however, include requirements which are specific to an end-use which may differ from or be additional to those for general purposes, and in section three of the standard, requirements for particular applications are dealt with.

The standard contains a "fold-out" summary, which shows the chemical compositions of all the copper and copper alloys which are to be included in any one of the schedules for the wrought products. When including in the one document all the requirements from all existing British Standards for tubes certain anomalies became apparent, and where possible they have been eliminated. Corresponding amendments to the existing individual standards will be made.



(Left) High speed, low weight, rock drill with air-operated pusher leg. (Right) Rocker loader in operation. The loader has a bucket of 7 cubic feet capacity, discharging at a height of 47in at a point 21in behind the loader

Rock Drills and Mine Loaders

DEMONSTRATIONS were given recently by Atlas Copco (Great Britain), Ltd., Beresford Avenue, Wembley, Middlesex, of a new rock drill and a high-capacity loader for use in mining and tunnelling work. The pneumatic drill, known as the "Lion," is intended for use in conjunction with an improved design of pusher leg, and it can be seen in operation in one of the photographs we reproduce on this page. It combines high speed in operation with a low weight of only 66 lb, and its maintenance costs are stated to be very low. Normally designed for a working pressure of 85 lb per square inch, the drill, by a slight modification, can operate with air at 60 lb per square inch. With air at 85 lb per square inch the drilling speed is stated to be up to 3ft per minute in sandstone with a 1·7in bit, and 24·5in per minute with a $1^{11}/_{32}$in bit in hard granite when the air consumption is 152 cubic feet per minute.

The drill has a 2¾in diameter piston with a stroke of 2¾in and with air at 85 lb per square inch it delivers 2000 blows per minute and rotates at 200 r.p.m. The rotation chuck takes a 4½in by ⅞in hexagon collared shank. A new design of double-opening direct-flow valve is stated to contribute to the heavy impact and increased drilling capacity. The rotation mechanism incorporates a rifle bar opening with four pawls and rotation is effected on the return stroke. A supply of flushing water is conveyed through a large concentric axial tube in the machine, and its flow is controlled by a valve interconnected with the throttle of the drill.

As can be seen in the illustration one air and one water hose only are used for operating both the drill and the pusher, and a particular point in the design is the simplification of centralised controls on the back head and the handle of the drill. One of two small throttle levers on the back head controls the sequence of initial feeding, water flushing, and then the actual drilling operation. The other lever controls the valve which regulates the feed pressure of the pneumatic leg. When it is required to retract the leg a valve lever in the handle is depressed and the leg extension is returned by air pressure. During drilling this lever is used for intermittent variation of the thrust imparted by the pusher leg.

With this lever the leg can be retracted quickly and easily during drilling, for resetting when its limit of extension has been reached. For this leg resetting operation the drill is not stopped and the operator simply takes the weight of the drill and holds the lever in whilst the leg is automatically retracted by compressed air. When the foot of the leg reaches its new anchor position the handle lever is released and drilling feed at once recommences, with the pusher in operation. The makers point out that the "Lion" drill can be modified to a sinker or arranged for chain and screw feed equipment.

A new lightweight rock drill, known as the "Terrier," which has been developed, weighs some 24½ lb. It has a 1⅛in diameter by 1⅛in stroke piston, giving 2650 blows a minute with an air consumption of 46 cubic feet per minute at 85 lb per square inch. It can be supplied with a standard rotation chuck for ⅞in by 4½in drill or a chuck for ⅞in by 4½in steels.

The improved large-capacity rocker-shovel loader, introduced by Atlas Copco and shown in our second illustration, is intended for use in tunnels which have a width of 7ft to 8ft and a minimum height of 7ft. Its 7 cubic foot bucket has a discharge height of 47in to a distance of 21in behind the loader. A 15 h.p. air motor actuates the bucket mechanism and a 12 h.p. air motor is used for tramming the loader. Both of these motors are of vane construction, and during the demonstration the effective way in which they and the air controls have been silenced was particularly noticeable in heavy working.

During digging all loads are transmitted to the buffer bar of the bogie. At the discharge position the arms of the bucket contact buffer springs. The loader has a clean-up range of 104in, and during operation the machine is automatically centred and locked when discharging the bucket. The main controls for tramming and bucket swivelling and discharging are conveniently grouped in two lever quadrants at the side of the machine above the operator's platform, from which there is a clear view of the working area. A quick-release diaphragm valve enables all air to be immediately exhausted from the pneumatic system of the machine when necessary, and the air control levers can be locked for safety. Both of the motors and other working parts of the machine are automatically supplied with oil from a central lubricator of sufficient capacity for about ten working shifts. In addition to effective lubrication, particular attention has been paid to sealing the mechanisms against the ingress of water and dust to reduce wear and the need for maintenance to a minimum.

The machine was demonstrated as arranged for dip loading and for this purpose it was fitted with an air winch at the rear. The wire rope of this winch was anchored some distance to the rear of the machine on the level track and its air system coupled to that of the traction motor with the controls interlocked. Thus, when the traction motor was used to draw the machine away from the digging point, the normal adhesion of the wheels on the inclined track was automatically and effectively supplemented by the pull of the winch. The air consumption of the loader is stated to be 205 cubic feet per minute, and its net capacity from 53 to 73 cubic yards per hour, depending upon the quality of the rock handled. A special version of this machine is fitted with a higher deck for filling larger cars, and it requires a minimum working height of 7ft 10in.

Trent and Mersey Canal Deviation

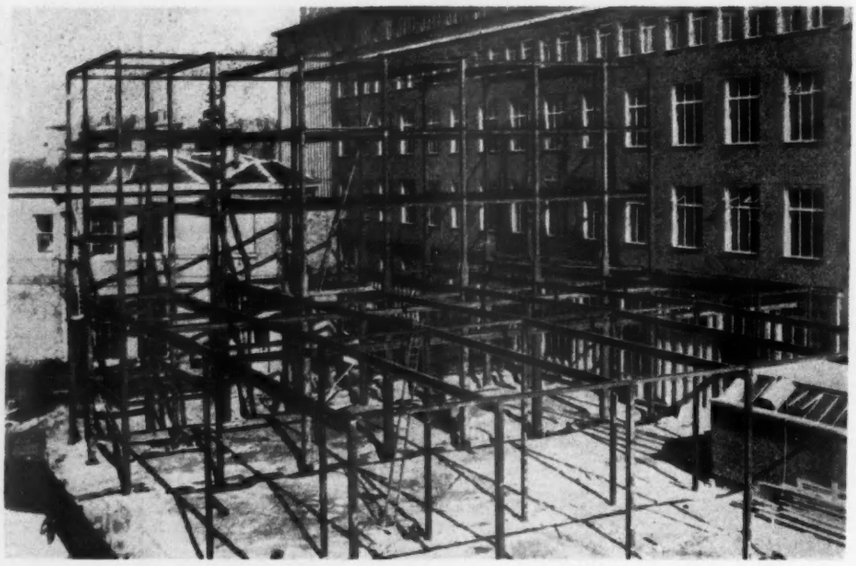
A DIVERSION of the Trent and Mersey Canal is being carried out by British Transport Waterways at Marston, near Northwich, in Cheshire, in order to avoid the danger of a breach of the canal through nearby abandoned salt mine shafts. The diversion is about 650 yards long and 55ft wide, and is a completely new section of canal. Marston is on the main line of the Trent and Mersey Canal between Anderton and Middlewich, a section which carries about 60,000 tons of traffic annually between the Mersey ports (including Manchester) and the Potteries and the Midlands. The old mine shafts were sunk many years ago for digging rock salt. Since the workings were abandoned in 1928, one of four shafts only a few yards away from the canal bank and sunk 300ft to the excavations below, has been severely affected by salt solution, resulting in a collapse of the brick lining and an enlargement of the underground cavity.

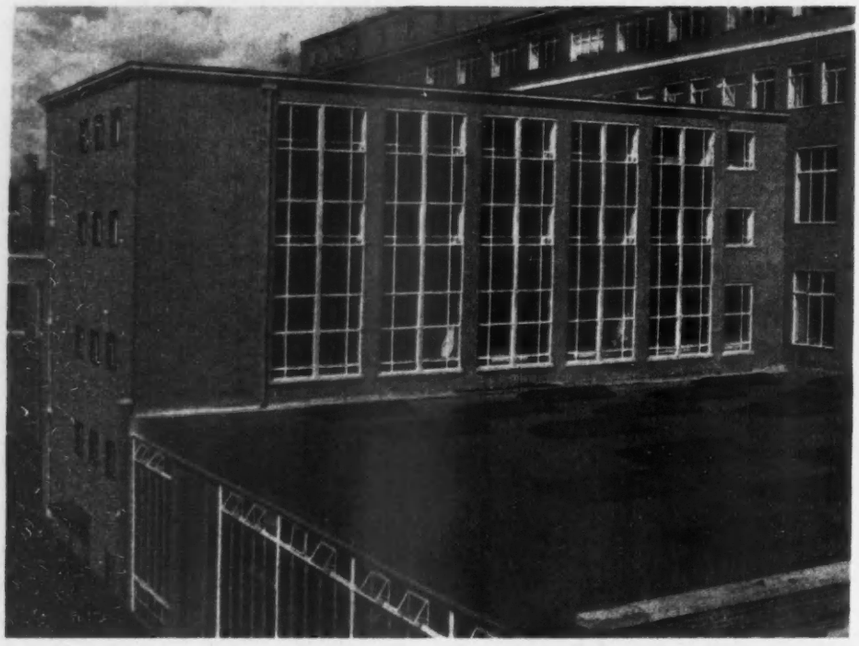
Despite the tipping of thousands of tons of material to try and block the shaft, it has dropped about 10ft since 1928 and the collapses have become more frequent and more extensive in the last few years. The edge of the growing crater, where the shaft reaches the surface, is now so near the canal that it presents a real risk to the canal bank. Further tipping of material would not have saved the situation, so it was decided that a diversion of the canal was the only effective remedy. The new route will be subject to the normal brine subsidence of the area and the canal walls are thus being constructed in concrete 2ft thick and extending 3ft below water. The total cost of the deviation, including purchase of land, will be £30,000. The contractor is George Dew and Co., Ltd., who is doing the work under the general supervision of Mr. E. W. Ratcliffe, the north western divisional engineer, British Transport Waterways. Another important waterways development in the same area is taking place at Sutton (near Northwich), on the Weaver Navigation, where a diversionary channel, 1600ft long, is being constructed to avoid the disused Sutton Locks. The new channel will be 120ft wide at the normal water line and 12ft deep. The work is part of the £260,000 programme of development for the Weaver Navigation.

LLOYD'S WRECK RETURNS.—The returns of merchant ships totally lost &c., issued by Lloyd's Register of Shipping for the quarter ended June 30, 1957, show that throughout the world twenty-nine ships of 23,279 tons gross were lost consequent upon casualty, of which four ships of 1806 tons were owned in Great Britain and Northern Ireland. The corresponding totals for ships condemned, broken up, &c., were eighty-five ships of 139,432 tons and forty ships of 66,990 tons respectively.

Cambridge University Engineering Laboratory

Post-war plans for the engineering department at Cambridge reached an important stage in 1952, when a building of 54,500 square feet was opened. It was described in "The Engineer" of November 21, 1952. An addition to this building, namely a four-storey centre wing and a single-storey block has been completed and was opened informally by the vice-chancellor of the University on February 25. A south wing, with a floor area of 28,700 square feet, is under construction, and will house fluid mechanics laboratories. In the new buildings opened this week are mechanics of machines and structures research laboratories, a fatigue laboratory, control engineering lecture room, control room and laboratories, and staff and lecture rooms



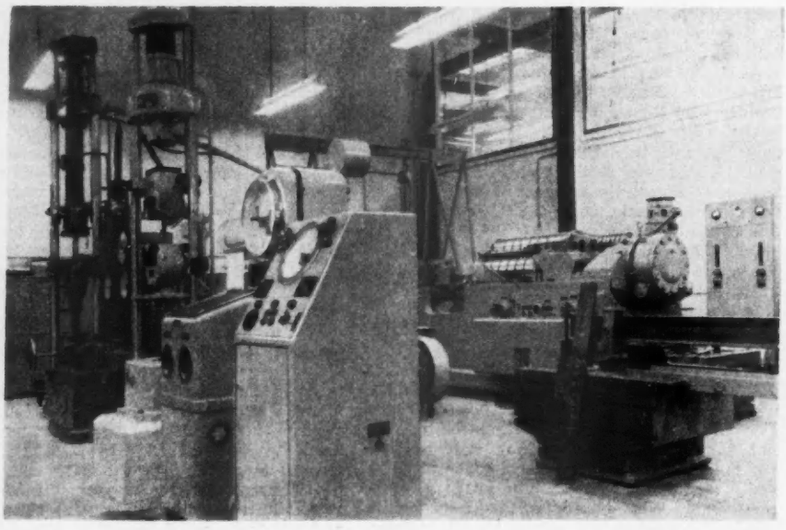


The four-storey wing is the first multi-storey office or laboratory building to have been designed by the plastic method. It is particularly apt that a method devised and developed by Professor Baker and his research team should find its first multi-storey application in this engineering building at Cambridge. The saving in weight of steel due to the plastic method of design is estimated at 25 per cent. The lightness of the steelwork sections is apparent from our first illustration, which shows the steel structure of the multi-storey block and of the single-storey block in the foreground. The completed building in the background is the extension opened in 1952. The second illustration shows the two new blocks completed, again with the single-storey laboratories in the foreground. The steel frame is welded, with heavy welded beam-to-stanchion connections. The beams span 33ft, in both the multi-storey and single-storey areas; the latter has a ceiling height of 20ft, and the relationship of span to height is architecturally pleasing. The design also allowed an economy in head room in the four-storey building, by allowing main beams with smaller depth than would have been required in a more orthodox bolted design. The steelwork contractor was Harland and Wolff, Ltd.

Here we show part of the fatigue laboratory, which covers 1450 square feet on the ground floor of the four-storey block. Its equipment includes a 60-ton Schenk direct stress machine, a 10-ton Losenhausen universal fatigue testing machine, a 10-ton Losenhausen pulsating tension machine and various other machines and rigs, including a machine for fatigue testing tubular specimens under alternating torsion, by resonance vibration under very high frequencies.

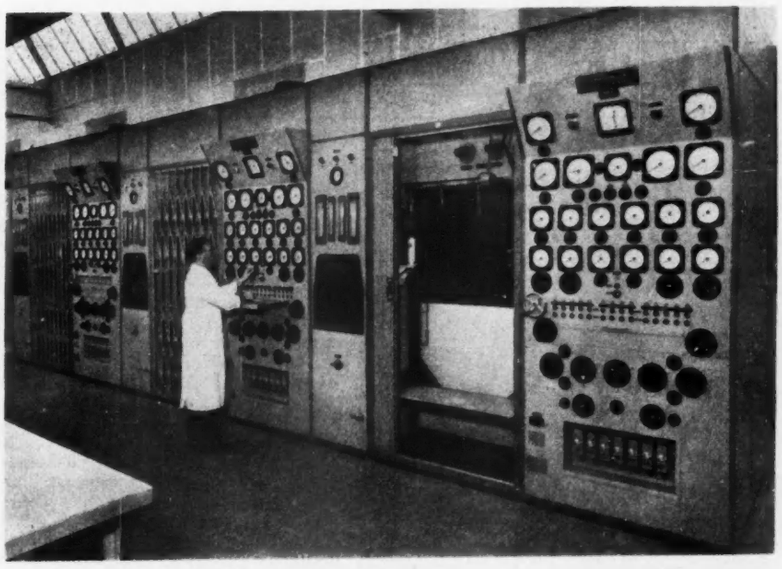
Apart from the undergraduate teaching experiments which will be carried on in the mechanics of machines laboratory, research will be done on non-linear vibration. This work is in three principal branches, namely the effects of non-linearity arising when a system vibrates with large amplitudes, a study of vibration isolation by use of non-linear springs, and research on machine tool dynamics.

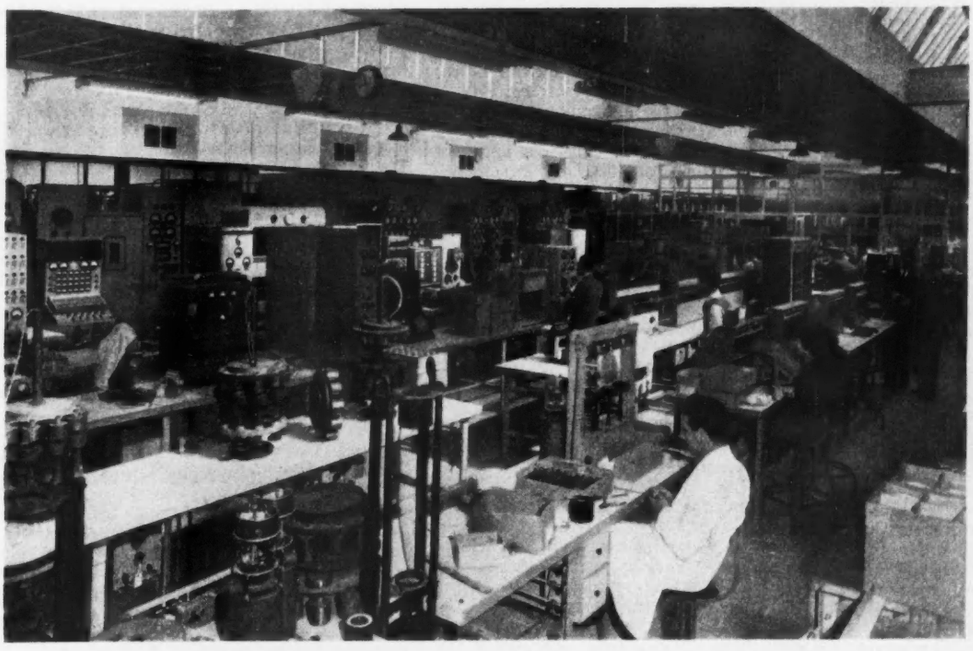
The control engineering rooms will be used for a post-graduate course lasting a year. A separate research laboratory will accommodate six students. Its equipment includes provision for work on control systems with predicted time of changeover to give the best performance with varying loads, as well as changing input, and for recording and analysing random processes. The computing room will house analogue computing equipment



Valve Factory at Paignton

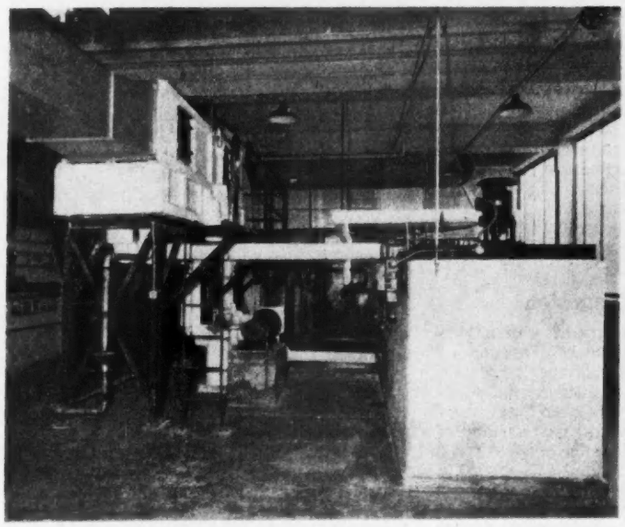
A new factory for the manufacture of special valves by Standard Telephones and Cables, Ltd., was opened last month at Paignton, Devon. It is one of the eight main S.T.C. factories in Great Britain. Until September 1940 the company's valve manufacturing work was centred at North Woolwich but then, for strategic reasons, the production of valves, crystals and magnetic materials was dispersed by transference to Ilminster, Somerset, where, despite the drawbacks of the site, the valve division remained for nearly sixteen years. When it was proposed to relocate the valve division in London, the Government invited the company to consider consolidation in the West Country. The Paignton factory, which is the outcome of these considerations, was occupied in July last year and it now employs 1050 workers, 30 per cent of whom are women. It is a single-storey building with 150,000 square feet of floor area, on a 46-acre site

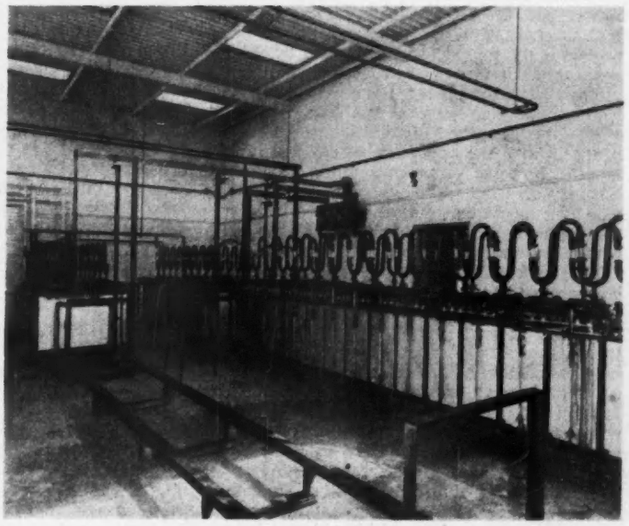




It is equipped to produce mainly special valves for radio communications, including microwave and high power valves as well as gas-filled tubes. Design and development work is done in an engineering building which has a chemical laboratory, a model shop and a special area in which long-life submarine repeater tubes are made under laboratory conditions, with conditioned air, dust freed by electrostatic precipitation.

The illustration on the left shows the main assembly shop; in the background are the vacuum pumping stations, one of which is illustrated above. Part of the air conditioning and refrigeration plant is shown below, left. Among the services provided throughout the factory are hot water, cooling water, oxygen, hydrogen and nitrogen. Oxygen and hydrogen are generated in the basement cell room, shown below, and nitrogen is produced by burning air with hydrogen





SHORTER REPORTS

Sir James Swinburne, Bt., F.R.S.

TO-DAY, Sir James Swinburne, F.R.S., celebrates his 100th birthday. We cordially join in the many congratulations that will reach him on this auspicious occasion. Sir James now enjoys a well-earned retirement after a long period of active years in the engineering profession. Until he was well over ninety, he was chairman of Bakelite, Ltd., of which company he is now honorary president. His work on plastics goes back to the early years of the present century.

Sir James was born at Inverness and began his engineering training in the Gorton locomotive works, Manchester. Subsequently, he was associated with Swann in the manufacture of incandescent lamps and with Crompton in dynamo development and production. His work in electrical engineering led to Sir James being elected a Fellow of the Royal Society in 1906. Sir James has been a member of the Institution of Electrical Engineers since 1885, and served the Institution as president in 1902. He is a member of the Institution of Civil Engineers and a past-president of the Faraday Society. Sir James has many interests, prominent among them being music, horology and sociology, on all of which he has written lucidly during his distinguished career.

London Atomic Energy Insurance Conference

INSURANCE delegates from fourteen European countries are attending a three-day atomic energy conference in London, as guests of the British Insurance (Atomic Energy) Committee, to discuss problems concerned with the insurance of atomic reactors. This committee, which was set up nearly two years ago, representing the British insurance companies and Lloyd's underwriters, musters the resources of the British insurance market to form a single atomic energy insurance "pool" with which to provide the underwriting capacity needed to cope with the immense sums involved in covering atomic energy risks: for example, on an installation such as Calder Hall, the amount of cover required in respect of material damage alone is of the order of £30,000,000, ignoring any third party liabilities. The committee is also a means of ensuring maximum co-operation between individual insurers and of facilitating the exchange of technical information between one insurance market and another.

A statement issued by the British Insurance Association, 59–67, Gresham Street, London, E.C.2, recalls that the conference (which ends to-day) is the second to be sponsored by British insurers who are in the forefront of atomic energy insurance developments; the previous one was held in London in February last year. The main objects of this second meeting are to determine, in the light of the experience of the past twelve months, how the various insurance markets of Europe may work more closely together to provide insurances on a comprehensive basis for the many reactors now being built or contemplated, particularly on the Continent of Europe.

The conference is being conducted in three languages, the proceedings being informal, on the lines of a working party. Among the more interesting subjects examined in this way is the British Insurance (Atomic Energy) Committee's recommendation contained in its detailed report on atomic energy risks and their insurance, that liability for radiation damage should be channelled to owners and/or operators of private reactors. The report, published in June, 1957, says that the object of such channelling is to ensure that any claim from a third party should be made simply and solely against the reactor owner or operator, who would be able to take out insurance in connection with radiation hazards on behalf of all against whom claims might be made, including those awarded the construction contract, sub-contractors and suppliers of materials and component parts.

In the United Kingdom, this kind of approach to the problem has been accepted by the Government, who propose that the owner of a reactor shall be under an absolute liability and shall be required to insure to a sum of £5,000,000, or else show that he has liquid assets available to that amount. Other subjects being discussed at the conference include:

Methods of co-operation between the atomic energy insurance pools of different countries, including questions of reinsurance and co-insurance one with another; the desirability of obtaining agreement on the factors necessary for the proper evaluation of atomic risks for insurance purposes; bases of premium rating for material damage and third party risks.

National Physical Laboratory

LAST year a comprehensive review of the organisation and programmes of work of the National Physical Laboratory was carried out by a committee of the research council of the Department of Scientific and Industrial Research. As a result, the research council has approved certain changes in organisation, which will become effective about the end of March. It is stated that one of the most important changes is a reorganisation of the work at present carried out in the divisions of electricity, metrology and physics, and in the test house at the National Physical Laboratory. These four units are to be replaced by three new divisions to be called standards, applied physics and basic physics.

The standards division will be responsible for all fundamental work on standards of length, mass and time; of electrical and magnetic quantities and also of temperature. Basically it will consist of the present metrology division, expanded to include certain work on standards now carried out in the electricity and physics division. The superintendent will be Dr. H. Barrell, at present in charge of the metrology division. The applied physics division will be responsible in general for work in the field of classical physics of fairly immediate value to industry (but excluding optics, all of which will continue to be done in the light division). The principal areas covered will be electrotechnics, acoustics, heat and radiology. The test house, which hitherto has come under administration, will become an integral part of this division, but will preserve its identity under Mr. H. Bowley. The superintendent of the applied physics division will be Dr. B. Wheeler Robinson, who is in charge of the present physics division. The basic physics division will be responsible for pioneering developments in certain branches of non-nuclear physics which have potential industrial applications in the less immediate future.

The council recently recommended the creation of a new post of deputy director of the N.P.L., and Dr. Edward Lee (at present director of operational research in the Royal Naval Scientific Service) has been appointed to it. He will take up his duties on March 31.

University Expansion

A STATEMENT about the expansion of universities was made in Parliament on Thursday of last week by the Chancellor of the Exchequer, Mr. Heathcoat Amory. He recalled the announcement made in November, 1956, when the Government approved proposals for the starting of university buildings up to the value of £10,400,000 in 1957, £12,000,000 in 1958, and £12,000,000 in 1959. The Chancellor went on to say that the existing economic situation imposed upon the Government the need for great restraint in this as in other fields of Government spending, but the Government was satisfied that if the country was to get the increased output of graduates needed and was to secure the full benefits of future advances in science and technology, the current rate of university building programmes must be not only maintained but increased.

The Chancellor then stated that, after considering recommendations made by the University Grants Committee, he had given authority for a programme to be prepared on the basis that university building projects would be started up to a value of £15,000,000 in each of the four years 1960–63. It would be difficult to put a precise figure on the increase in the number of university students which would be made possible by a building programme of £60,000,000 over four years. Discussions between the University Grants Committee and the universities, the Chancellor explained, were based on an increase to about 124,000 students by the mid-1960s, with the possibility of a further temporary increase of 10 per cent in the second half of the decade, a level which it should be possible to achieve with the programme envisaged. In fact, the Chancellor added, the universities were expanding faster than had been expected; though the future rate of increase could not be assessed with any confidence, the increase beyond 124,000 foreseen for the late 1960s might well prove to be permanent. The question would be kept under review.

In reply to questions which followed his statement, the Chancellor emphasised that the Government had given "very high priority indeed" to educational development as a whole. Apart from the capital expenditure involved in the expansion, the programme would involve a substantial increase in current grants to universities when the time came. Apart from existing universities, the expansion programme envisaged the early building of, he thought, a University of Sussex.

Phosphating of Sheet Steel Surfaces

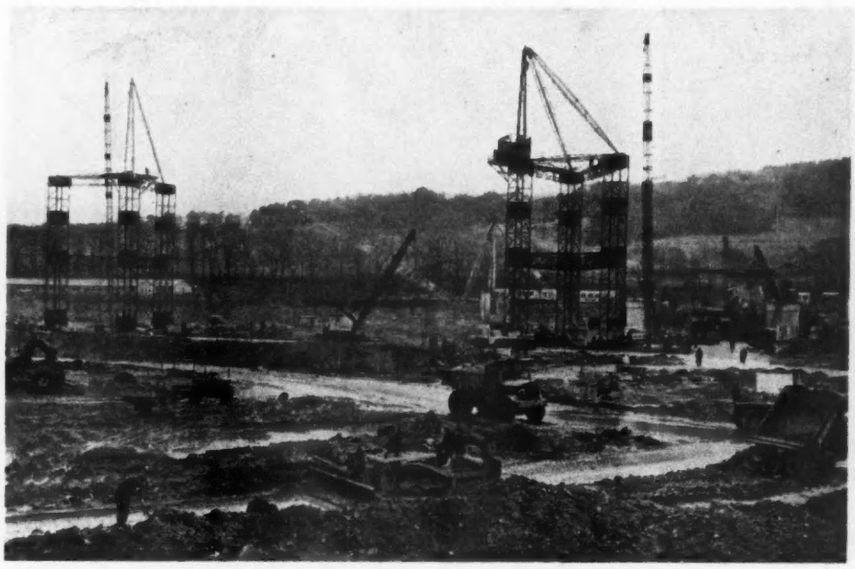
THE Walterisation Company, Ltd., of Purley Way, Croydon, Surrey, has developed a new phosphating process for direct application by cold spraying to clean sheet steel surfaces prior to painting known as the "SPC" process.

In this process, the solution is applied by means of a spray gun, similar to that used for paint spraying, but having the working parts made of acid-resisting material. An air pressure of 30 lb to 40 lb per square inch should be used and the chemical must be contained in a glass or acid-resisting container.

The technique of application is stated to be extremely simple, consisting of degreasing, phosphating, washing and drying. Degreasing may be carried out by wiping with white spirit, trichlorethylene or other suitable organic solvent and the surplus solvent is removed from the surface by wiping with a dry rag.

A period of five minutes is allowed to elapse to permit the residual traces of solvent to evaporate. The "SPC" chemical is then sprayed on to the surface to wet the area completely. It is allowed to remain in contact with the steel surface for at least five minutes and is then washed off thoroughly with clean water. The surface is then dried by wiping with clean rag and finally by means of warm air or in an oven. The parts are then ready for immediate painting.

The phosphate coating produced is said to be extremely fine grained and to have a coating weight of approximately 60 milligrammes per square foot. Whilst this weight will vary with the material treated, the surface hardness and condition, the coating weight should be within the range of 40 to 80 milligrammes per square foot; 1 gallon of the chemical will treat approximately 1000 square feet of steel surface.



The site of reactor "A" at Hunterston, as seen from the seaward side, looking across the end of the turbine hall excavation. Two of the four derricks which will be used for placing the main structural concrete are almost complete

Progress at Hunterston Nuclear Power Station

AT Hunterston, on the Ayrshire coast, Scotland's first nuclear power station is being built for the South of Scotland Electricity Board by The General Electric Company, Ltd., in association with Simon Carves, Ltd., The Motherwell Bridge and Engineering Company, Ltd., and Mowlem (Scotland), Ltd. Temporary works were started at the end of August last year, but permission to begin permanent work was not granted until the middle of October. By that time, 1½ miles of temporary road had been laid and information about the rock formation at the site had been confirmed.

Since then attention has been concentrated largely on the foundations of the first reactor and the turbine hall; work is shown in progress in this area in the illustration. Having removed, on average, 8ft of soil and "green" rock at the reactor base, blasting and excavation began prior to mass concreting. This mass concreting, involving the pouring of 3000 cubic yards of concrete, has now been completed and work has started on the reinforced concrete raft above it. The raft will incorporate 8000 cubic yards of concrete with 400 tons of reinforcing steel.

The turbine-hall excavation, covering an area approximately 675ft by 130ft and going to a depth of about 13ft, is now practically finished, and work has started on the cooling water inlet culverts. To obviate blasting near the first reactor once the structural concrete has been placed, excavation for the irradiated-fuel storage pond has also been completed, but this area will be required for precasting the heavy concrete beams of the reactor building, so the loose rock has been replaced for the time being.

Most of the blasting for sewers and drains has now been finished; a 21in main drain has been installed. A complete workshop and prefabrication apron are being constructed on site. The workshop, which is now approaching completion, will be a twin-bay, steel-framed building served by two 40-ton travelling cranes. It is designed so that four steam-raising units, each 80ft long and 20ft in diameter, can be assembled simultaneously. The apron in front of the workshop will be used for prefabricating the six tiers of each 70ft diameter spherical reactor pressure vessel. The workshop and apron are on the centre-line of the two reactors so that the Goliath crane, which will be used for raising and placing the steam-raising units and pressure-vessel sections, will pass over these construction areas. This crane, which will be the outstanding piece of constructional equipment employed on the site, will have a height and span of 200ft, so that it will be able to straddle a completed reactor building; it will be capable of lifts of 350 tons. The massive prefabricated sections of the crane legs are already being assembled on site and the bogies on which they will be mounted are in position on their tracks.

A great deal of work has been involved in the provision of temporary buildings and services. For instance, an 11kV electrical distribution system has been installed for an expected total capacity of 10MVA. One rather unusual load on this system is a 500kW heater in a 12,000 gallon water tank which supplies the concrete batching plant. This heater raises the temperature of the water almost to boiling point so that concreting can continue when there is a slight frost.

Mineral Insulated Thermocouple Wires

A NEW kind of thermocouple wire is being marketed by Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2. This wire has been specially designed for measuring a wide range of temperatures under extreme conditions. It is stated to be particularly suitable for use in atomic energy plants and steel mills. Four different kinds are available for temperatures ranging from −200 deg. up to +1000 deg. Cent., with ceramic-packed single or double core in metal sheathing. Diameters vary between 0·5mm and 1mm, as tabulated below.

The wire can be bent to a curve having only five times the wire diameter and into any configuration without risk of earthing or shorting the cores. It has extremely low heat capacitance at the hot junction and, therefore, a high response sensitivity. It is suitable for high-pressure working conditions, requires no additional insulation, is simple to install and is specially suitable for multi-point measurement where space is limited.

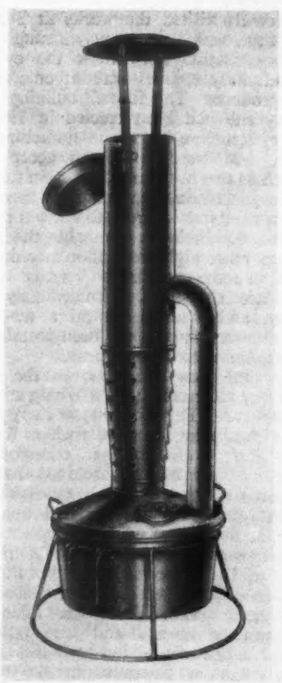
Main Particulars of Thermocouple Wire

Designation	"PR6121 A/00"	"PR6240 A/00"	"PR6250 A/00"	"PR6250 A/01"
Sheathing material	Steel	Iron	Copper	Copper
Overall diameter	1mm	0·5mm	1mm	0·7mm
Insulating material	MgO	MgO	MgO	MgO
Core	Chrome/alumel	Constantan	Constantan	Constantan
Number of cores	2	1	1	1
Polarity	Alumel/negative (magnetic)	Constantan negative (magnetic)		
Resistance between core and sheath	Better than 1 Megohm/metre			
Resistance of the cores (per metre) (approximately)	40 ohms	40 ohms	6 ohms	15 ohms
Temperature range	0 to 1000 deg. Cent.	0 to 600 deg. Cent.	−200 deg. to +400 deg. Cent.	
Overload:				
Permissible short-term maximum temperature	+1350 deg. Cent.	+700 deg. Cent.	+500 deg. Cent.	
Minimum bending radius	5mm	2mm	5mm	3mm
Standard length	30m	125m	30m	60m

Simplified Space Heating

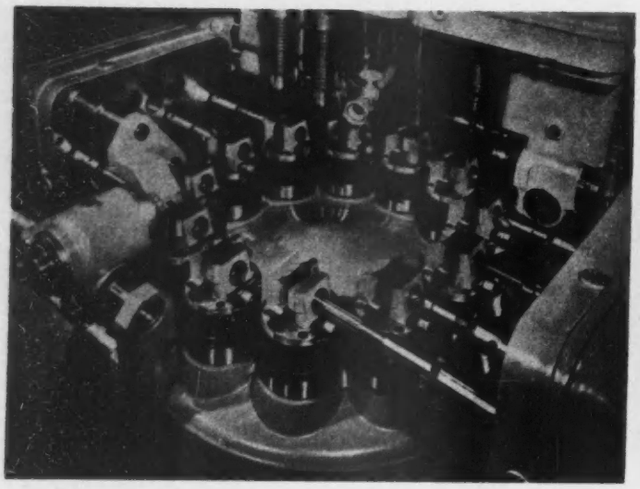
WE recently inspected the "Salamander," a powerful space heater made by ACE Heaters, Ltd., Chapel Street, Liverpool. The heater is devoid of working parts and exceedingly simple in principle: it will burn waste sump oil or other low grade fuels without obtrusive smoke. The fuel is contained in the bowl at the bottom, which holds 8 gallons. The stove is started by lighting a small quantity of paraffin or other distillate on top of the crude with waste paper or, to avoid deposits in the stove, a special torch. The combustion chamber is the louvred, tapered duct below the flue: hot gas is entrained by an intake facing upstream, turned through 180 deg. and led back down a pipe into the top of the bowl. The oil is thereby heated and the vapour rises into the combustion chamber: air enters through the louvres and burns in the hot gas. An adjustable air inlet is provided on the filler cap: air entering here burns in the space above the fuel and increases the rate of evaporation. It can be conceived that the top of the bowl and the stack become very hot and radiate strongly: the exhaust is relatively clean, and in a fairly large workshop an exhaust pipe would not be necessary.

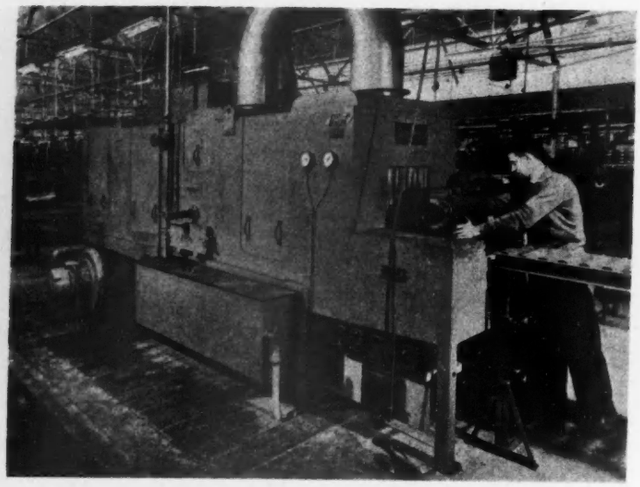
The operation of the heater is, clearly, devoid of difficulty, and maintenance is confined to refilling, which must be done with the stove extinguished (by closing a damper between bowl and combustion chamber). An essential safety precaution is that water be not allowed to enter the bowl, since it would boil and expel hot oil.



A "Salamander" assembled for use outdoors

For such purposes as drying out plaster or houses to be decorated, an adapter for 6in stove pipe can be supplied: an 18in length of pipe incorporating a damper fits into it.





Figs. 1 and 2 (Left)—The "Planetomat" is seen here loaded with rocker arm workpieces: notice in the left foreground the milling cutter to profile the contact face. (Right) A crankcase being loaded into the washing machine: in the centre can be seen one of the two rams that advance to close the longitudinal oil gallery in the casting

Engine Manufacture

WE recently visited the works at Staines of Petters, Ltd., which is part way through a five-year reorganisation to increase the output of small stationary engines without enlarging the factory grounds. The former buildings at the Causeway site had been erected in 1914 as a temporary structure for the manufacture of the Lagonda, and were unable to accept heavy loads such as overhead conveyors: in the course of the reorganisation, areas had to be successively cleared of machines in order to allow a new roof to be erected. Besides rearranging the plant to save space, more high-production machines were acquired, in some cases from overseas. All iron castings are shot-blasted immediately before inspection and machining, and a new airless "Wheelabrator" plant has been installed in a separate building for this purpose.

Among the new machines is the special-purpose tool illustrated here, a Witzig and Frank "Planetomat." This is built to carry out the complete machining of valve rockers for o.h.v. engines and, with tooling changes, parts for various engines can be machined from either of two patterns of casting. It has twelve stations, of which one is for loading and unloading: however, as the ring of work-holders rotates, the individual workpieces are given a planetary rotation in the opposite sense, so that drills working on different workpieces can be advanced by the same head. There are three heads, two advancing inward and one downward. Cycle time is one minute ten seconds. Another German machine already in use is able to generate, rather than form, valve seats: the cutter head is conical and the cutter advances along a generator as the head rotates.

Particular attention is, we noted, paid to the cleanliness of engines. Location faces are ground on the crankcase and, to prevent abrasive dust being stuck to the castings as the soluble oil dries, they are immediately passed through a Dawson alkali wash. Another washing machine, evolved specially for this factory, appears in our second illustration: it is capable of a high throughput and of flushing through the long oil gallery drilled from end to end of the multi-cylinder "PC" engines. (See page 911, June 14, 1957.) The engines are loaded into the plant on pallets, which in the case of the "PC" locate them precisely. Inside the machine two sets of rails are provided, one set fixed and the other able to rise and fall and also reciprocate. The "walking" rails lift, traverse and set down the pallets at successive stations; on the return motion a rack and pinion causes the engine at the first washing point to rotate one-and-a-half times in the spray. At the second station the pallet is set down upon pointed locating pegs; hydraulic rams then advance to press upon the crankcase end walls where the oil gallery breaks through, and the gallery is washed out under pressure. At the third station a final wash is given and then excess moisture is blown off the component. The engine assembly bays are not in the same space as the machine tools.

The output of the works is at present of the order of 800 to 1000 engines in a forty-four-hour week. All deliveries are made by road, employing a fleet of articulated vehicles; each tractor has two platform trailers, one of which is acting as an "outwards" store while the other is on the road.

Completion of the Clifton Bridge, Nottingham

THE prestressed concrete road bridge across the River Trent at Nottingham—Clifton bridge—was opened to traffic on February 18. The appearance of the bridge is shown by the accompanying illustration. The main span is 275ft, with spans of 125ft on each side of it and three subsidiary 90ft spans on the south side. The central 100ft of the main span is a suspended span, with a balanced cantilever construction on each side of it formed by the 125ft side span and the contiguous 87ft 6in length of the main span. The suspended span is built of precast prestressed beams, which were cast in forms positioned on top of the cantilever section, and then rolled into position using a gantry. The cantilevers were built *in situ*. The form of construction is reflected in the completed structure by the "blocking out" effect which can be seen at each end of the suspended span. The capping beam which runs right along the bridge is precast in white concrete, contrasting with the fluted, but otherwise untreated, surface of the structural concrete of the spandrels.

A detailed description of the bridge was given in the THE ENGINEER of June 7 last. The consulting engineers were Messrs. R. Travers Morgan and Partners, and the contractor James Miller and Partners. The city surveyor of Nottingham is Mr. R. M. Finch M.I.C.E.

Metal Treatment Baths

A NEW process has been developed by the Paints Division of Imperial Chemical Industries, Ltd., for eliminating fumes and steam from aqueous metal treatment baths. This "Serseal" process, as it is known, seals the tank surfaces with a layer of inert material which not only checks fumes and steam, but also reduces the amount of heat needed to keep the bath at a working temperature. It is claimed that, as the process eliminates steam and condensation, exhausting equipment can often be dispensed

The main span of 275ft of the Clifton Bridge is the largest constructed in this country so far in prestressed concrete. The bridge is designed for the Ministry of Transport's abnormal load specification, and has a 22ft carriageway, a 9ft cycle track and a 5ft 6in footpath

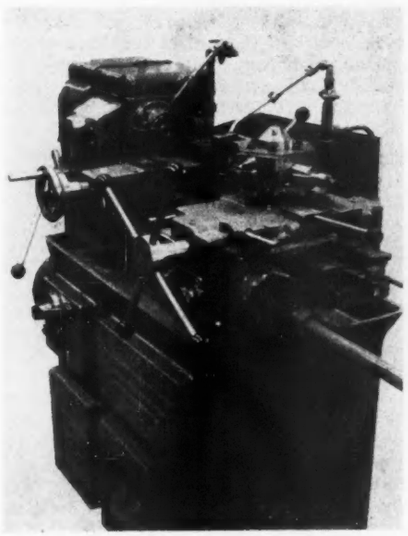
with, whilst working conditions are improved and shop condensation and structural corrosion are retarded.

The process can be operated without alteration to a processing tank, and although it was developed primarily for use in baths producing heavy phosphate coatings—such as those employed in the I.C.I. "Granodine" 101 process—it has now been extended to other "Granodine" processes. Alternative grades of "Serseal" are available to suppress acid fumes and spray from pickling tanks and to conserve heat in alkaline paint stripping vats.

Small Turret Lathe

A TURRET lathe version of the 1in capstan lathe made by Murad Developments, Ltd., Stocklake, Aylesbury, Bucks, has a turret slide working stroke 14in long. Its spindle is bored 1 7/16in diameter and work up to 11½in diameter can be swung over the bed or 5in diameter over the cross slide.

The machine is driven by a two-speed motor through a two-speed gearbox and a four-step pulley, and the sixteen spindle speeds available



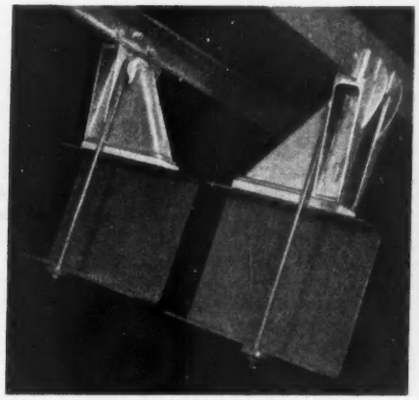
Turret lathe with a 1in capacity collet and for turning work up to 14in long

range from 62 to 18,000 r.p.m. The motor speed is selected by operation of the pedal, to be seen at the foot of the cabinet in the accompanying illustration, and the gearbox by the three-position lever on the left. A pneumatically operated spindle brake is automatically applied when the forward/reverse lever is in the neutral position. The spindle brake is also applied by slight inwards pressure on the gearbox lever when in the neutral position.

The turret slide is equipped for both hand and power feed. The six rates of power feed are from 0·002in to 0·019in per spindle revolution, and automatic disengagement is provided by adjustable stops. Turret indexing is effected by hand. A hand-operated cross slide on a fixed saddle has a maximum movement of 4½in.

Body Bearer Pedestal

A PLATFORM body devoid of wheelboxes on a conventional ladder-framed commercial vehicle chassis has its cross-members well above the chassis side members. On a wooden body deep longitudinals are fitted to fill this gap, but lightweight bodies have hitherto often required pedestals built up from extruded sections and sheet material by riveting, a costly process. A pedestal which should have wide application for such bodies is now available from the Northern Aluminium Company, Ltd., Banbury: it is a die casting in Noral 117 (B.S. 1490 LM4M). As can be seen in our illustration, it is virtually a tetrahedron with the upper and lower edges at



Cast aluminium underframe pedestal in light alloy

right angles, so that under compressive loads it is stable in both directions. In fact, it is located on the chassis by a U-bolt, some pedestals being fitted facing backwards and others forward, to resist accelerating and braking loads. Side forces and toppling moments are taken by the bolts through the body cross-member, the holes for which are drilled by the body-builder. Light alloy parts can be attached directly, steel parts are expected to be protected with zinc chromate.

Fatigue and static tests are still in progress, but it appears that factored loads can be of the order of tons and well above the strength of conventional channel sections. At present only 7in high pedestals are available, giving a frame-to-floor height of 10in to 12in, but 5in and 9in pedestals are expected to be available shortly.

Shielded Arc Welding Equipment

A NEW semi-automatic, inert-gas-shielded, metal-arc welding equipment has been introduced by Quasi-Arc, Ltd., Bilston, Staffs, for welding all metals over ⅛in thick. It consists of the three main items to be seen in the accompanying illustration—a welding rectifier, a wire feed and control unit, and a welding gun with either water or air cooling. With a water-cooled welding gun the equipment is suitable for currents up to 600A and with an air-cooled gun up to 300A.

The self-contained welding rectifier incorporates a combined transformer and selenium plate metal rectifier. This set is mounted on wheels for easy mobility and provision is made for

Semi-automatic inert-gas-shielded metal-arc welding equipment

mounting two gas cylinders at the back. A built-in control panel in the set contains the wire feed motor control circuits, operating relays, gas solenoid valves and other controls for all the services required for the process. Operating power is supplied from a centre-tapped, 110V transformer. For remote control purposes there is provided a small rheostat which covers the full range of welding current available.

A portable wire feed and control unit, which weighs only 40 lb, can be taken to any convenient position for the welding operation, and, if required, its wire reel can be taken off to facilitate transport. The wire feed motor speed range is variable from 60in to 600in per minute, and can be remotely controlled from the welding position. The water-cooled welding gun can be replaced by an air-cooled gun when the equipment is used on sites where a cooling water supply cannot be arranged.

The maker states that when welding aluminium with a 1/16in wire at 245A, a ¼in fillet can be deposited at an overall speed of 18in per minute with the new equipment. A weld of similar size can be deposited on steels at a speed of 15in per minute.

Marseilles-Algiers Submarine Telephone Cable

THE submarine telephone cable between Marseilles and Algiers has been laid by the cable ship "Ampere III," belonging to the French Posts, Telegraphs and Telephones Administration, and the operation has demonstrated the changing technique in submarine cable laying brought about by the development of the articulated flexible repeater. The cable is the longest single undersea telephone cable for two-way operation yet laid. It has a length of 485 nautical miles, contains twenty-eight repeaters at intervals of 16 nautical miles and is designed to carry sixty simultaneous telephone conversations.

To enable the "Ampere III" to carry out the laying operation, it was necessary to modify the starboard picking-up and paying-out gear and this work was carried out by the Telegraph Construction and Maintenance Company, Ltd., which had manufactured the original gear in 1929. The new starboard gear has a capstan of 6ft diameter, with a tread of 88cm, which is operated when paying out and has been specially designed to accommodate large articulated flexible repeaters, of French design, having a diameter of 19cm. Provision was made for accommodating hydraulic brakes designed by the Etablissement Paul Duclos of Marseilles and in addition, a mechanically operated water cooled brake is fitted on the inboard side of the gear to give additional braking effort when paying out aft. The mechanical brake drum is fitted to a stub shaft which is usually occupied by an inboard capstan. When it is required to work forward over the starboard bow the whole brake assembly can be removed and replaced by the capstan.

There are two holding brakes, one operating on the outboard capstan brake rim and the other, designed as a dual purpose brake, operating either on the brake rim fitted to the inboard capstan or on the water cooled brake drum, whichever is in use. Fleeting knives, designed to be retractable from the capstan face, are positioned forward and aft on the outboard capstan and have a 12in lateral traverse and share the fleeting thrust when paying out aft. The gear, which is driven by the original 120 h.p., three-cylinder, vertical steam engine, is capable of picking up cable at two speeds, 0·76 and 3·06 knots, based on an engine speed of 250 r.p.m. Theoretical performance data indicates that the picking-up over bow speeds and lifts are 7¼ tons at ¼ knot continuously, 18 tons at ¼ knot for short periods and 5 tons at 3 knots continuously. When paying out aft a variable braking effort of between 0 and 1¼ tons can be applied, in addition to the braking effort available from the two hydraulic brakes, by adding weights to the mechanically operated water cooled brake. Other alterations include the provision of deck leads and a dynamometer supplied by Johnson and Phillips, Ltd.

Industrial and Labour Notes

Unemployment

During a debate in the House of Commons, on Monday, the Minister of Labour, Mr. Iain Macleod, said that in January unemployment at 1·8 per cent of the total number of employees was only one-tenth of 1 per cent higher than the average for the last ten years, which was 1·7 per cent. Employment itself remained at record levels, and at the end of December was higher than in any previous December. It must be borne in mind, the Minister added, that January and February were the seasonal peaks of unemployment. Usually, there was very little between those two months, and often it was only the weather that decided whether the figures went up or down between January and February. Then, in March, or in April at the latest, the seasonal improvement started.

The Minister went on to say that unemployment in Great Britain had increased between January and February by 28,000, which meant that the percentage had risen to 1·9. That was a much smaller increase than the leap in the figures in January, but, the Minister said, it appeared to be a real and not a seasonal increase. The changes in the areas which caused most concern were as follows :—In Wales, there had been an increase of 2000, giving a rate of 3·8 per cent, and in Scotland, an increase of 6000, giving a rate of 3·6 per cent. The South Western Region, about which there was some concern, had not changed and was still at 2·4 per cent. The regions showing relatively the largest increase between January and February were the East and West Ridings and the Eastern and Midlands regions.

Dealing specifically with the situation in West South Wales, the Minister pointed out that most of the old tinplate works and mills were concentrated in a small area of less than 100 square miles, with a working population of about 180,000. Employment at the older works in that area had fallen by between 6000 and 7000 and unemployment had risen to between 8000 and 9000. It should be recorded, however, that three-quarters of those who had permanently left the steel and tinplate works had already found other employment. Nevertheless, the Minister said, he was by no means content with the position.

Wage Claims

Last week it was announced that the National Coal Board had rejected the claim, submitted by the National Union of Mineworkers, for a 10s. a week increase for day-wage men in the industry. At a subsequent meeting of the union executive, it was decided to take the claim to the coal mining industry's National Reference Tribunal. The tribunal already has before it the union's claim for a forty-hour week for surface workers and a sick-pay scheme for manual workers, which has already been rejected by the Coal Board.

Another pay claim about which a decision was given at the end of last week is that put forward on behalf of workers in civil engineering contracting. The claim was for an increase in the basic rate of pay and for a forty-hour week without loss of pay. The claim, which was considered by the Civil Engineering Construction Conciliation Board, was rejected by the employers' representatives. Explaining the rejection, the Federation of Civil Engineering Contractors said that the claim, if granted, would amount to 8d. an hour on the basic rate, or roughly a 20 per cent increase. That would be an extravagant claim at any time, but in present circumstances was completely unrealistic. Civil engineering operatives, the Federation explained, had recently received an increase of 1d. an hour under the sliding scale agreement. The first priority for both sides of the industry, it was added, must be the reduction of costs. Not until that had been successfully accomplished was it possible to contemplate any further improvements in the wages and working conditions of the industry, which already stood high in comparison with industry generally.

Exports in January

In a survey of the United Kingdom's overseas trade in January, the Board of Trade says that the slight reduction (1 per cent) in exports in January, compared with the fourth quarter of 1957, was more than accounted for by a largely seasonal decline in shipments of food, beverages and tobacco. In the other broad groupings of goods, exports in January equalled or exceeded their fourth quarter levels. In particular, the Board states, engineering exports rose in January by £4,000,000 to a value of £119 million, textiles were up by nearly £1,500,000 and fuel shipments were also £1,500,000 higher.

In the engineering group, exports of road vehicles once more did well, and at a total of nearly £34,000,000 they were 14 per cent above the monthly rate in the fourth quarter. Exports of cars and chassis were particularly good, reaching a value of £17,000,000 in January against a monthly average of £14,000,000 in the fourth quarter of last year. Shipments of commercial vehicles and chassis continued to improve and at £8,500,000 were 17 per cent above the monthly rate in the fourth quarter. Aircraft exports, however, were £1,500,000 down in January after increasing between October and December last. In the machinery divisions, non-electric machinery maintained the high rate recorded for the final quarter of last year, and exports of electric machinery and apparatus were 9½ per cent up. The Board's survey adds that exports of metals in January were unchanged in total value at £39,000,000. There was a decline of £1,000,000 in the value of shipments of iron and steel (mainly tinplate), but that was offset by an increase in exports of "manufactures of metals." Exports of non-ferrous metals maintained their fourth-quarter average.

Overseas Trade Fairs

The President of the Board of Trade, Sir David Eccles, was questioned in Parliament last week about policy on overseas trade fairs. In reply, Sir David said that the Exhibitions Advisory Committee submitted a report last July, and it was proposed to act on the conclusions as occasion arose "within the limits of the money available."

The committee recommended that in overseas fairs where official Government stands were installed, it was not sufficient for the United Kingdom to provide mere inquiry desks. A stand with display was essential, and such displays, the committee urged, should normally be concentrated on a single industry or group of industries. Approaches should be made to trade associations in some of the capital goods industries for their co-operation in organising them. Another conclusion reached by the committee was that the number of these stands in any year should be limited, and the fairs chosen for them should vary from year to year. The main cost of these stands, the committee felt, must be borne by the Board of Trade but firms or industries whose goods were shown on them should be expected to lend exhibits free of charge and, normally, to pay for transport and for export staff where their attendance was necessary. The committee also recommended that in fairs organised on the basis of national pavilions the responsibility for constructing and managing the pavilions should normally rest with the Board of Trade. The Board should let out the space at a rent as high as was consistent with the primary purpose of filling the pavilion with a representative show of British goods even if it was insufficient to cover all costs.

Finally, the committee directed attention to the fact that the United Kingdom is not spending as much as its main competitors on official participation in overseas fairs. Expenditure on United Kingdom official participation in these fairs, the committee said, should remain under constant review.

Designing Equipment for Human Use

The Engineering and Allied Employers' West of England Association is arranging an "appreciation course" on "Designing Equipment for Human Use." It is to be held at Engineers' House, The Promenade, Clifton Down, Bristol, 8, from May 5 to 16.

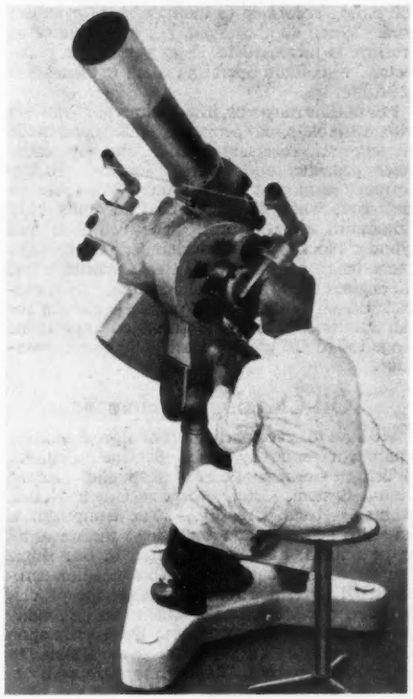
In its announcement about the course, the Association says it is intended for staff concerned with the design of machines and equipment of all kinds which have to be manually operated. Design engineers know a great deal about how machines work and what may be expected from them, but frequently they have relatively little information about the human operator. The course is intended to help remedy the deficiency in this field of knowledge, for, to obtain maximum efficiency, it is essential that the equipment designer should take into consideration both the characteristics of machines and the capacities of operators. The course, it must be added, is to be restricted to twleve members, so that thorough discussion can take place and some practical work can be done.

Shipyard Hours

On Tuesday, the Shipbuilding Employers' Federation informed the Confederation of Shipbuilding and Engineering Unions that it could not grant the claim for a forty-hour week in the shipyards. A claim for holiday pay at the rate of £2 10s. a day was also rejected. It will be recalled that similar demands submitted on behalf of workers in the engineering industry were refused towards the end of last year by the Engineering and Allied Employers' National Federation. The Shipbuilding Employers' Federation has said that it is not opposed in principle to the idea of a shorter working week. It has directed attention, however, to the disappointing output of the shipbuilding industry after so much has been spent and continues to be spent on re-equipping and modernising the yards. Most of this disappointment, it was stated, was due to loss of time at starting and stopping hours, absenteeism, strikes and restrictive practices which were still too apparent in the industry.

Coudé Refractor

For some years following its re-establishment at Oberkochen (Württemberg), the firm of Carl Zeiss was fully occupied with problems of organisation and manufacture of a wide range of optical equipment, so that it is only recently that the making of astronomical instruments has again been taken up. The first result of the new policy is the Coudé refractor shown in our illustration, which was developed for solar observations as part of the programme for the International Geophysical Year. Beside visual



Coudé refractor for solar observations

observation, the refractor offers the possibility of taking miniature photographs at frequent intervals, with or without colour filter.

The principle of the instrument is that the telescope can be pointed at any object in the sky, while the observer remains comfortably seated in a normal position instead of having to change his position constantly. To achieve this, the light passing from the telescope objective to the focal plane is bent (coudé) by being reflected through the hollow declination axis and into the likewise hollow polar axis by two plane mirrors made of quartz or *ZK*7. For any place of installation the polar axis has a fixed direction, namely, that of the celestial polar axis. Consequently, the image plane of the telescope remains stationary. In the Zeiss design this advantage is enhanced by making the plane mirror at the intersection of the declination and polar axes reversible. Thus, the focal plane can be transferred as required to the lower or upper end, giving the possibility of observing alternatively at two fixed positions at the instrument, and with different accessories. Besides, since the rear half of the tube is absent in the refractor, it is no longer necessary to reverse the tube in the neighbourhood of the meridian position in order to avoid the mounting pillar.

The illustration shows the observer seated at the lower end of the polar axis. By means of a simple changing device the "Contax" camera can be brought into the place of the eyepiece. A like device is located at the upper end of the polar axis on the housing for the H_α monochromatic filter.

All parts on the two sides of the polar axis turn together with it, including the controls, which comprise the following: clamping at the hour angle and declination (the two star knobs top left); coarse adjustment of declination with reading scale (top right); mirror reverser (bottom left); fine adjustment of declination and coarse adjustment of hour angle (both concealed by the eyepiece extension).

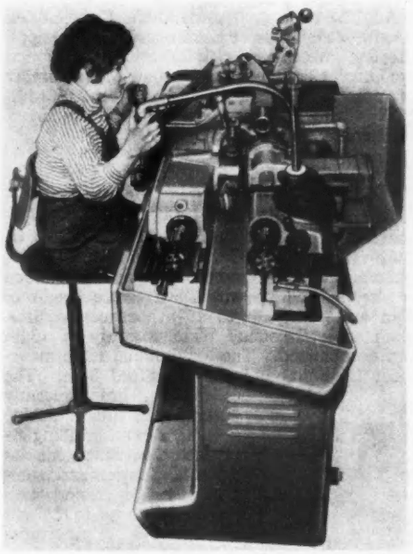
The hands of the observer rest on the housing of the synchronous motor for the hour drive which can be switched to stars, sun or moon. The fine adjustment of the hour angle is also located here.

The star knob at the lower end of the tube serves for operating an iris diaphragm in front of the objective which can be either a 150mm apochromat (as in the refractor illustrated here) or an achromat. For the special objects of solar observation two short tubes are mounted on the two eyepiece extensions. These participate in the declination adjustments of the telescope and with their optics image the date and clock time, as well as a stepped photometric scale, beside the sun's image on the film.

Precision Capstan Lathe

We have received details of the "Pantocop" turret lathe made by Tönshoff and Co., Dortmund-Lütgendortmund, German Federal Republic (Embassy Machine and Tool Company, Ltd., 248, Watford Way, London, N.W.4.). The machine, which is shown in the accompanying illustration, has two turret slides both supported on horizontal slides and equipped with automatic longitudinal feed; in addition, the front turret can be supplied with automatic cross feed.

The headstock spindle runs on ball bearings and is equipped for collet clamping by hand or for automatic bar feeding. It has six or nine



Two-turret capstan lathe, both turrets being simultaneously controlled by the operator. The control levers incorporate push buttons for automatic feeds

forward speeds produced by driving from either a two- or a three-speed motor and a three-step vee-pulley transmission. For reverse speeds a reversing gearbox is fitted. Engagement and stopping is by a combined clutch and brake.

The front turret is equipped for drilling, reaming, thread-cutting and short turning operations, and is controlled by a lever situated on the operator's left. The rear turret is mounted on a cross-slide so that it can move both longitudinally and transversely, and is controlled by the operator's right hand by means of the pantograph lever shown. This turret is intended for turning, boring, relief cutting and parting off. Both operating levers are arranged so that they can be pulled towards the body in crosswise directions easily and comfortably with a minimum of effort. Push buttons are arranged in the lever handles enabling the electromagnetic clutches for the mechanical feed to be operated without relinquishing control of the levers. A thread-chasing attachment is mounted on the headstock and can cut taper threads by setting over a header bar. By means of additional equipment internal threads can also be chased. The arrangement is claimed to result in a great speeding up of the machining time as well as a reduction in the handling time, together with a decrease in fatigue. The machine is fitted with a copying attachment which comes into operation automatically by indexing.

Régie Nationale des Usines Renault

A turnover of over 170 milliard francs was realised during 1956, according to the recently published annual report of the Régie Nationale des Usines Renault. This nationalised undertaking is the most important French automobile manufacturer, employing, on December 31, 1956, 57,470 people (mainly in its factories at Flins Choisy, Le Mans, Orléans and Billancourt), compared with 52,241 a year earlier. The company produced over 1400 vehicles a day, of which 27·1 per cent were exported. The new model, the "Dauphine," was built by the end of the year in daily quantities of 500 (800 in July, 1957), and the new tractors in quantities of about seventy per day (100 in July, 1957). Every effort was made to fulfil the industry's undertaking to export two-thirds of the current production increase.

If expansion of the industry has tended to slow down this must be attributed to increased running costs, the Suez crisis, lack of improvements to roads and parking facilities, and the threat of still heavier taxation. Renault has taken the risk of maintaining its investment programme, so as to do its share to prevent the depression spreading further through the industry. French private car production in 1956 increased by only 18 per cent over 1955, compared with a 26·3 per cent increase during the preceding year. Commercial vehicle production remained unchanged. By comparison, Renault production increased by 24 per cent over 1955. The position is illustrated by the following tables.

Renault Vehicle Production in 1956

"4 CV"	112,050
"Dauphine"	78,136
"Frigate" and "Domaine"	28,954
	219,140
Commercial vehicles (including 2389 "Saviem-LRS")	45,119
Total production	264,259

Principal Continental Producers

	1956 (All classes)	1955 (All classes)
Germany	1,073,000	909,000
France	662,636	561,465
Italy	316,000	269,000

Production at the Renault factories thus, in 1956, amounted to 33·1 per cent of the French total, compared with 31·3 per cent the year before. Of its production of 219,140 private cars, 186,449 were sold in France.

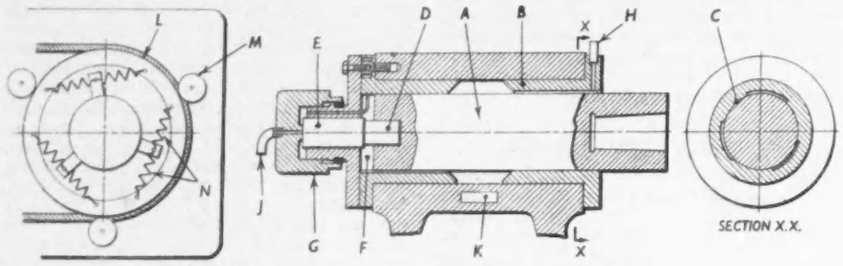
It may be of interest here to mention that there were sold in France in 1956, 921,089 second-hand vehicles (833,752 in 1955), an increase of 10·5 per cent compared with 12 per cent for new vehicles; the ratio of second-hand sales to new sales was 3 : 2, and would probably have been higher still had it not been for the restrictions following Suez. Purchasers prefer economical small cars less than five years old, though the discriminatory road tax may cause the demand for older cars to increase, in spite of their high running cost and contribution to traffic problems.

Exports increased by 17·4 per cent to 54,030 vehicles (as compared with 46,370 in 1955), constituting 45 per cent of all French vehicle exports. European countries absorbed 71·5 per cent; Asia 11·1 per cent, and North America 9·8 per cent.

Other activities included the production of diesel train sets for the S.N.C.F. and foreign railways; further development work on a free piston gas generator/gas turbine locomotive, and delivery of three rubber-tyred trains for the Châtelet-Porte des Lilas line of the Paris Metro.

High Precision Lathe Headstock

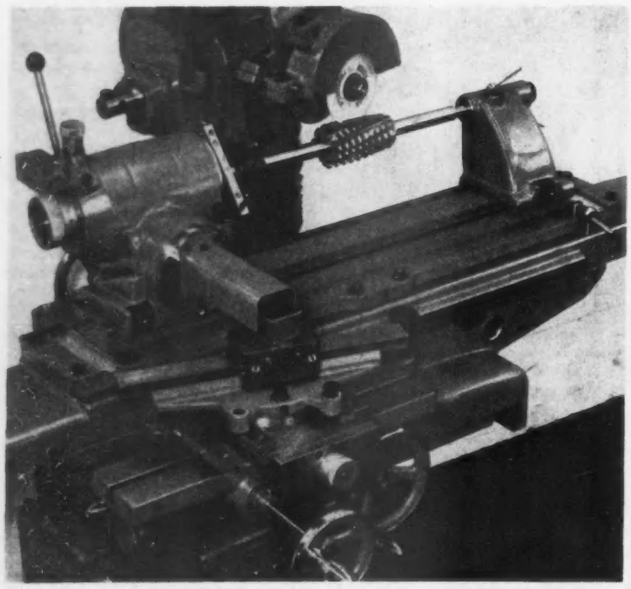
For the machining of flats or profiles on end surfaces, e.g. plastic lenses, a lathe headstock has been developed by the Philips Research Laboratories at Eindhoven* which permits face turning with an error in the direction of the axis of rotation of less than 0·005 micron (as shown by the grooves cut by fine diamond-tipped cutting tools). This headstock also finds application in the machining of v.h.f. cavity resonators for the precision measurement of dielectric losses in solids. Here local unevenness of the walls must be kept small by comparison with the depth of penetration of the high frequency current, which is about 1 micron for the wavelengths considered. Our accompanying illustration shows the construction of the headstock, which has a steel spindle *A* running in bronze bearing block *B* with three bearing surfaces *C*. An "improved wood" end piece *D* fitted to the tail end of the spindle rests against a stationary thrust block *E*, the front surface of which is lapped and set accurately at right angles to the spindle axis. By maintaining a constant sub-atmospheric pressure in the space *F* the force on the thrust block is kept constant. Axial displacement is obtained by means of the micrometer *G*. The vacuum in chamber *F* also causes an inflow of lubricating oil to the main bearing, through the port *H*. Since the cylindrical bearing surfaces are lapped to an accuracy of 1 micron, a drop in temperature of only 5 deg. Cent. would cause seizure. Thermostating at 30 deg. Cent. is accordingly resorted to. In order to avoid torsional vibrations, the drive is through a separately supported pulley by means of springs as shown in the left portion of the illustration.



A—Steel spindle.
B—Bronze bearing.
C—Bearing surface.
D—"Improved wood" end piece.
E—Thrust block.
F—Vacuum space.
G—Micrometer.
H—Oil inlet.
J—Oil outlet.
K—Heater element.
L—Pulley.
M—Support rollers.
N—Springs.

Lathe headstock for machining accuracies of less than 5×10^{-4}mm in a direction parallel to the axis

* *Philips Technical Review*, 1957, Vol. 19, page 68.



Cutter grinder with taper grinding attachment. The offset grinder bar transmits a lateral movement which is transformed into a rotation by means of a steel tape which passes in a loop over the headstock spindle

International Mechanical Engineering Congress

It is announced that the seventh International Mechanical Engineering Congress will be held at The Hague from June 2 to 6. It is being organised by the Vereniging van Metaal-Industrieën (secretariat : 14, Burgemeester de Monchyplein, The Hague ; telephone, 18.52.81), and among the sponsoring organisations are BEAMA and the British Engineers' Association, London. The technical programme will deal with materials (plastic, thin sheet, nuclear and surface treatment) machining and processing, and consideration of cost and price. Excursions will be arranged to a number of places of interest, technical excursions, including the Royal Netherlands Steelworks at Ymuiden, the Rotterdam Dockyard Company, Wilton-Fijenoord (Schiedam), Royal Dutch Forge (Leyden), Van der Heem N.V. (The Hague), Nederlandsche Kabelfabriek (Delft), Nederlandsche Electrolasch Maatschappij (Leyden), Machinefabriek Reineveld (Delft), and the Utrecht Techni-show, together with a number of post-congress trips including Heemaf, Stork, Philips, and DAF, and visits to the Zuiderzee, Amsterdam, and Brussels.

Tool and Cutter Grinder

Our illustration shows the model "SW2" universal tool and cutter grinder made by Ludw. Loewe and Co., A.G., Berlin, NW 87, German Federal Republic. The machine, which is already well known, has a centre height of 4½in and takes up to 19½in between centres. With an intermediate plate, a swing of 13¼in can be obtained. The longitudinal table movement is 19½in, and the cross-feed 8½in. The maker has recently equipped this machine with a spiral grinding attachment which enables milling cutters and reamers to be ground with diameters up to 225mm and with a maximum length which varies according to the spiral angle but which with an angle of 15 deg. is about 250mm.

The attachment comprises a swivelling indexing head and an adjustable guide bar. As the table is fed along, the guide bar imparts the required rotation to the head and hence to the workpiece. The adjustment of the guide bar can easily be carried out by means of a diagram, starting from the known spiral angle of the cutter. The movement at the guide bar is transmitted to the headstock spindle by means of a cross bar to which is attached a flexible metal band which is looped over the spindle.

Marine Diesel Engine

The Volund marine diesel engine, built by Volund Company, Ltd., Copenhagen, is intended mainly for coastal vessels and fishing craft. The engine is a single-acting, four-stroke design, which, in its non-pressure-charged version, is made with two, three, four, six and eight cylinders, developing 150 to 660 b.h.p. at 375 r.p.m. All sizes have a cylinder bore of 300mm and a stroke of 410mm. Mean indicated pressure is stated to be 7·5 kg per square centimetre, maximum compression pressure 32 kg per square centimetre, and maximum combustion pressure 48 kg per square centimetre. Engines other than the two-cylinder design can be fitted with exhaust turbo-supercharger when they develop 330 to 880 b.h.p., according to the number of cylinders used. When supercharged, the mean indicated pressure is increased to 11 kg per square centimetre. Maximum operating speed in all cases is 425 r.p.m.

For marine purposes, installations are available with variable-pitch propeller, with fixed-blade propeller and reversing gearbox, and with fixed-blade propeller and reversing engine. In the normally aspirated design, the pistons are of cast iron, while the turbo-charged units have aluminium alloy pistons. The bed-plate and cylinder block are of "Meehanite," the cylinder liners being of centrifugally cast special alloy. All engines have Bosch fuel injection. An industrial version of the Volund engine is also on the market. Fuel consumption is stated to be in the range 160 to 165 grammes per brake horsepower-hour.

Oil-Cleaning Equipment

We have received particulars of oil-regenerating equipment made by Gebr. Schlegel, Fellbach (Württ.), German Federal Republic (agent : Liquid Systems Ltd., Norwich Union House, Wellesley Road, Croydon). The equipment is stated to be automatic and allows the waste oil to be refined, boiled and filtered in one single operation, eliminating all decomposition products. The residue remaining after the process is a dry, compressed cake which can be readily scraped away in a few minutes. Depending upon the amount of dirt in the oil, recovery is stated to be up to 95 per cent. Regenerators are available for mineral oils, kerosene, organic solvents and vegetable and animal oils. The process is a so-called soft refining by heating electrically under about 36 lb per square inch pressure in contact with a refining agent, by which means all oxidising substances are separated out, while low boiling impurities are distilled off. Capacity of the plant varies from 3·3 gallons and 0·6kW to 44 gallons and 7·2kW. The oil flows from the separator continuously, the whole process being completed in one to five hours.

Czechoslovak Reactor

The first Czech atomic reactor has come into operation at the Institute of Nuclear Physics near Prague. The reactor is of Russian manufacture, develops 2000kW, and works with 10 per cent enriched uranium and ordinary distilled water as moderator. It is intended for research in technology nuclear, biology and radio-chemistry. The remainder of the institute is still under construction, and it is hoped to complete it by 1961.

Preparatory work is said to be under way for the construction of an atomic power station of 150MW. This will be erected with the assistance of Russian experts within the framework of the "Commission for mutual economic assistance" (COMECON).

Transport Agreement with Austria

A railway rate agreement was signed in Luxembourg recently between the Austrian Federal Government, the Member States of the European Coal and Steel Community and the High Authority. The agreement abolishes "breaks in rates" at the Austrian frontier and thereby extends the Community's system of international railway through-rates to the transport of coal and steel crossing Austrian territory between the German-Austrian and Italian-Austrian frontiers.

The American Scene

BY OUR AMERICAN EDITOR

Too Much Aluminium?

Kitimat is a scenic and splendidly isolated spot in the Canadian province of British Columbia. Years ago its mountain lakes and tumbling streams caught the eye of Aluminium Ltd., the second largest producer of the light metal in the world; in one of the boldest ventures in industrial history, the company decided to turn a wilderness into a vast new source of aluminium. To supply the necessary power, it first dammed the Nechako River. Then, to give passage to the falling waters, it blasted a 10-mile tunnel through the side of a mountain. To convert this potential energy into electricity, a power station was created in a huge cave hewn out of the mountain's interior. Finally, Aluminium, Ltd., built smelting facilities, designed eventually to produce some 330,000 tons of metal per year. Under its original timetable, Kitimat, which now can turn out 180,000 tons annually, would have reached full capacity by 1960. Since then, however, several changes have been made in the schedule. Toward the end of last year, Aluminium, Ltd., announced that it has postponed the installation of 80,000 tons of capacity at the smelter. Together with previously reported moves of the same kind, the latest deferment brought the company's total cutback there and elsewhere, to 240,000 tons, equivalent to the entire expansion once planned for 1957–60. This "stretch-out" at Kitimat is no mere whim on the part of the management of Aluminium, Ltd. It represents a hard-headed appraisal, by one of the oldest and most successful producers, of the current and prospective state of aluminium supply and demand. On all counts, there seems to be a good reason for caution. For the first time in years, production of aluminium in the United States and Canada has exceeded consumption. As a result, inventories are mounting and prices of semi-finished products have weakened. Moreover, large tonnages of new capacity currently are under construction. Indeed, primary capacity at the start of 1959 will exceed that of June 30, 1957, by 30 per cent. To be sure, the market for aluminium, which, in the post-war era, has increased by an average of 12 per cent yearly, still is expanding. Primary and secondary production capacity, however, is expanding faster. This state of affairs is highly unusual for the North American aluminium industry, which for decades has enjoyed a truly remarkable growth. Thirty years ago there was only one domestic source of the metal; the Aluminum Company of America, which, in 1927, produced exactly 81,803 tons. In the following year, Alcoa divorced itself from its Canadian subsidiary which is now Aluminium, Ltd. The Reynolds Metals Company, originally a fabricator of foil, poured its first ingot in 1941. After World War II, the Kaiser Aluminum and Chemical Corporation entered the field. By 1950, at the start of the war in Korea, the industry was turning out 1,257,000 tons a year. Spurred by the outbreak of hostilities—and by various Government guarantees—the three producers continued to expand. Even after the war was over, the race for more capacity went on. In addition, several newcomers have appeared on the scene. In 1955, the Anaconda Company launched Anaconda Aluminum, with 60,000 tons of ingot capacity. This year, three other concerns—the Canadian British Aluminium Company, the Harvey Aluminum Company and the Ormet Corporation will bring in an estimated 300,000 tons. The latter firm is a joint venture of the Olin Mathieson Chemical Corporation and Revere Copper and Brass, Incorporated. All told, primary aluminium capacity in North America to-day exceeds 2,500,000 tons. By early 1959, it will be in excess of 3,300,000 tons. Briefly, after nearly a decade of scarcity, aluminium to-day is in ample supply. Actually, the turn occurred last year, when shipments to both civilian users and the Government declined. In the United States, the largest customer for aluminium is the construction industry: it accounts for 25 per cent of total consumption. Other big users include the automobile, utility, machinery and aircraft industries, roughly in that order. In 1956, demand already had begun to lessen. In addition, Washington stopped buying the light metal for the U.S. stockpile. Finally, fabricated aluminium of European origin is now being sold in the U.S. at a discount from domestic list prices. The result has been a growing surplus.

Noteworthy though it is, the shift in the market has failed for the most part to slow down the industry's expansion. Aluminium, Ltd., of course, has deferred its Kitimat programme. Anaconda Aluminum has whittled the output of its 60,000-ton facility at Columbia Falls, Montana, to 75 per cent of capacity. Alcoa, which originally had planned to bring in a 150,000-ton plant at Warrick, Indiana, last year, has postponed completion until this year at the earliest. Last month, the firm also held up work on its expansion of smelting capacity and the construction of a new refinery at Point Comfort, Texas. On the whole, however, expansion schemes are still under way. For example, among the newcomers, the Canadian British Aluminium Company has put in pot lines for 80,000 tons at Baie Comeau, Quebec (described in our issue of February 7, 1958, page 219). Harvey Aluminum plans to produce 54,000 tons at The Dalles, Oregon. The Ormet Corporation will turn out 180,000 tons of ingots per year, of which Olin Aluminum will take two-thirds, with one-third going to Revere Copper and Brass. Reynolds Metals will add 112,500 tons to its plant at Listerhill, Alabama. Production is about to start though full operations will not be achieved until 1950. Also in 1959, Reynolds will bring in 100,000 tons at Massena, New York, raising its total annual capacity to 701,000 tons, from 488,500 tons at the present time. Kaiser Aluminum has just completed a 27,500-ton expansion of its works at Chalmette, Louisiana. It has begun production at its new facility at Ravenswood, West Virginia, with full capacity of 145,000 tons scheduled to be reached by mid-year. When its current round of building is completed, Kaiser Aluminum will have stepped up its annual capacity from 434,500 tons to 609,500 tons.

All the foregoing adds up to a lot of aluminium—too much indeed, for the present. Just how did the industry get into this situation? Some of the responsibility rests squarely with the U.S. Government. To encourage expansion during the war in Korea, Washington negotiated the now famous "put" contract with the domestic producers. In effect, if no other market could be found, it agreed to buy all the primary aluminium produced in the new plants. This privilege was to last for five years after the plants were completed. The American producers did not make use of the privilege during 1954 and 1955, when both commercial and military demand stayed high. But, beginning in 1956 the "puts" were being exercised, and it is anticipated that the U.S. Government will have to buy some 500,000 tons of the metal under this contract in the next two years.

The American aluminium industry generally tends to be relatively unconcerned about to-day's excess capacity and has set its sights for 1960. In that year, it expects to sell much more metal, not just to established customers, such as the construction and transport industries, but to new users as well. In particular, it is pinning its hopes on cans, automobiles and electrical equipment. Developing a major new market in any one of these fields soon would take care of surplus. In this connection, Reynolds recently signed a much-publicised agreement with the Esso organisation to supply aluminium cans for motor oil. Reynolds has undertaken to deliver the cans at a cost identical to that of cans made of tinplate. Since aluminium is more expensive than tinplate, Reynolds will recover scrap aluminium from the used cans. The company thus has launched an experiment—which will yield no immediate profit—to gain a toehold in the field. Similarly, Kaiser Aluminum recently announced that it was beginning production on an order of 5,500,000 grated cheese cans for the Kraft Foods Company. The can is drawn in one piece from aluminium sheet. While the unit cost may be higher initially, its weight, adaptability to special shape, and appearance make the can competitive. The use of aluminium in motor-cars is also on the rise. Buick, for example, has announced that its 1958 models use nearly twice as much of the metal as the 1957 cars did. The industry is also sanguine about the prospect for aluminium engine blocks and brake drums. Thus, several important new markets are evidently developing. Nevertheless, it should be remembered that during the past ten years, the busiest and most prosperous decade in American history, the use of aluminium increased only by an average of 12 per cent per year. In the next eighteen months, however, the industry is raising capacity by 30 per cent. Plainly, these figures point to a temporary period of oversupply, which will seriously test the staying power of some of the smaller American producers and fabricators of aluminium.

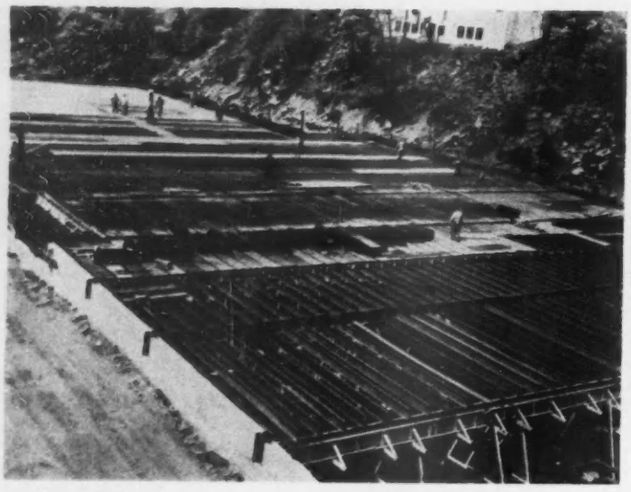


Fig. 1—Various stages of construction of a two-level car park at Dover, New Jersey : at far left upper deck concrete has been poured ; at the centre, shuttering is ready for concrete pouring; in the foreground " Junior Beams " have been placed

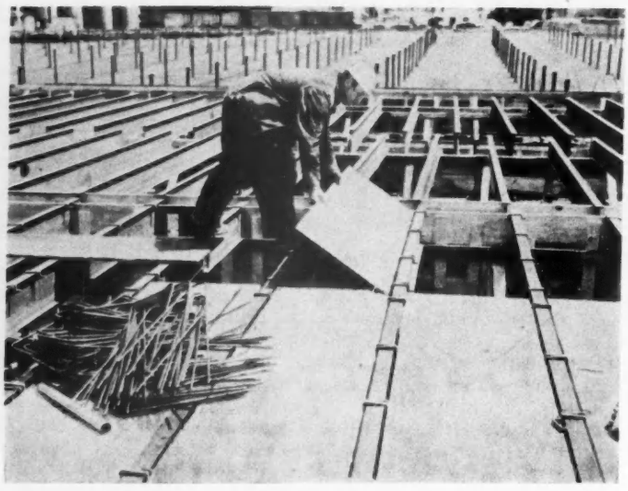


Fig. 2—Application of " K " clips, made of cast iron, in holding plywood shuttering panels in place between the top flanges of " Junior Beam " structural steel sections

Reinforced Concrete Construction for Car Park

A LARGE shopping centre, which is now under construction at Dover, New Jersey, will have one of the most unusual car parks in America. The structure consists of two levels which will park a total of 8500 automobiles by day. After dark, when the shops are closed, the top level will serve as an outdoor " drive-in " theatre, able to handle over 4000 cars. The construction of this building involves an interesting application of the so-called " Junior Beams," lightweight structural steel sections made by the Jones and Laughlin Steel Corporation, of Pittsburgh, Pennsylvania. The method employed involves the use of the "K System " of placing and holding moulds for the concrete deck and the embedding of the " Junior Beams " into the transverse reinforced concrete girders.

The upper deck of the parking area to be used for the " drive-in " theatre will be covered with asphalt and will contain " mounds " or " rises " on which cinema patrons will place the front wheels of their cars. This will enable the occupants of the cars to view the screen better. The mounds are designed so that they will not interfere with normal parking. One of the most interesting aspects of this project is the use of reinforced concrete girders which run across the width of the parking deck. These are supported on 8in unfilled standard pipe columns and are spaced, in general, on 25ft 6in centres. The pipe column rows are laid out longitudinally so that two 17ft 7in spaces alternate with a 23ft 4in space. As a result, the parking stalls on the lower level are approximately 17ft deep and are served by a 23ft driving aisle.

In constructing the upper level, wooden moulds for the concrete girders were built on the ground level between the supporting columns. They were then hoisted to the proper elevation with a fork lift truck and held in position with temporary intermediate shores. The floor joists were 12in "Junior Beams " weighing 11·8 lb per linear foot which required no fabrication and were simply placed on top of the girder moulds. After the " Junior Beams " were positioned, " K " clips were placed along the top flange of the beams to support 2ft by 8ft by $\frac{5}{8}$in plywood floor slab shuttering panels. The " K " clips were devised by Edward S. Klausner of New York and are small cast iron clips which hook over the top flange of the beams to support the plywood between the structural members. While they are capable of withstanding a static load of 850 lb, these clips fracture readily when struck by a light blow with a hammer.

Prior to the monolithic pouring of slabs and girders, reinforcing bars were placed in the girder moulds and steel mesh was rolled out for the slabs. The thickness of the concrete slab was 2$\frac{1}{2}$in. The plywood shuttering was readily stripped from the underside of the floor slab when the " K " clips were fractured. The construction of the parking decks required about 400 tons of " Junior Beams " and about 100,000 " K " clips. The upper deck was built to support a live load of 75 lb per square foot. It is claimed that the combination of lightweight " Junior Beams," " K " clips, and the embedding of the beams in the concrete girders, resulted in great savings in labour costs.

Law of Parity Conservation

SCIENTISTS at the University of Chicago and the Argonne National Laboratory recently proved, with the aid of a nuclear reactor at Argonne, that the law of " parity conservation " does not apply in the radioactive decay of the neutron. It is hoped that this new work helps to clear the way for a reconsideration of current physical theories with the possibility of new discoveries regarding the nature of matter and the universe. For nearly thirty years, the " principle of conservation of parity " has been a basic assumption among physicists. But last year it was demonstrated that parity did not hold for complex nuclei or mesons. These important experiments were carried out at the University of Chicago, the National Bureau of Standards, and Columbia University. Subsequently, many physicists have shown great interest in learning the results of such measurements on neutrons. It is believed that a test of the parity law properties in the case of the neutron would provide a particularly clear measurement for current or proposed theories concerning the basic properties of matter.

The neutron can be conceived of as a small magnet spinning on an axis running from its north to south pole. If the principle of parity is correct, the electrons produced by the decay of the neutron should be emitted equally toward both poles. Instead, the results of the Argonne-University of Chicago investigation proved that only about 62 per cent as many electrons came off in the direction of the south pole as in the direction of the north pole. The joint experiment was conducted by Valentine L. Telegdi, associate professor of physics at the University of Chicago, and Merle T. Burgy, Robert J. Epstein, Victor E. Krohn, Theodore B. Novey, Sol Raboy and G. Roy Ringo, of Argonne's physics division. The joint Argonne-University of Chicago research team worked for about six months on the experiment. Special equipment was designed, built and installed at the Lemont, Illinois, site of the Argonne National Laboratory to obtain the delicate measurements.

The neutrons used were " slow neutrons." Travelling at a speed of about 5000 m.p.h. they were obtained from the Argonne research reactor known as " Chicago Pile 5." The reactor is located at the Lemont site, 25 miles south-west of Chicago. The reactor uses enriched uranium for fuel and is cooled and moderated by heavy water. Access to the neutrons created within it is made possible by more than fifty openings which penetrate the eight sides and the top of the reactor. The experiment employed a method of " filtering " a neutron beam so as to eliminate neutrons pointing the wrong way and other unwanted radiation, such as gamma-rays. This method reflects the beam off a polished " mirror " of cobalt magnetised in the right direction. The decays of the neutrons were detected in a vacuum chamber by methods similar to those used previously at the Oak Ridge, Tennessee, National Laboratory and the Chalk River, Ontario, Laboratory to measure the lifetime of the neutron. This method used a fast electron detector with a plastic scintillator. The counts of this detector are recorded if they coincide with a count in a special detector, which is an electron multiplier with a large first surface of beryllium copper sensitive to the protons from neutron decay after they are accelerated to an energy of 10kV.

This measurement permitted the physicists to discriminate among several competing theories describing radioactive decay by electron emission. The most promising theories vary in their predictions with a measured ratio ranging from about 21 to 100 per cent. Even so, none of these theories appears to be in complete quantitative agreement with the experimental result, a fact which the physicists point to as illustrating the present uncertain state of understanding of nuclear physics. After the recently constructed large particle accelerators enabled physicists to disrupt the nucleus of the atom with " bullets " of tremendous energy, they produced a score of nuclear fragments. Many of these did not behave according to the principle of parity. Instead of a neat balance of left-handed and right-handed " spin " among the particles, some showed a predominance in one direction. Then, Professors Tsung Dao Lee, of Columbia University, and Chen Ning Yang of the Institute of Advanced Studies, at Princeton, New Jersey, challenged the validity of the parity principle. They advanced theoretical considerations that it was the law and not the nuclear fragments that provided the stumbling block. They also suggested three experiments which should prove whether parity existed for mesons or complex nuclei such as that of cobalt.

After these experiments, physicists speculated that if the parity principle did not apply in the sub-atomic particles, neither would it apply to the decay of neutrons. It was suggested by Dr. Telegdi that it would be of great interest to see whether the decay of the neutron showed this previously unexpected assymetry. The National Bureau of Standards experiment used nuclei of cobalt atoms, which are radioactive, i.e. decay into nickel by emitting electrons. The simplest of all nuclei, the free neutron, is indeed itself known to undergo such a decay process. Thus, all theories proposed to explain the results of

the National Bureau of Standards experiments primarily make statements about the neutron, and only apply to more complicated systems, such as the cobalt nucleus, indirectly. But the "parity law" had never been demonstrated to fail in the case of the neutron itself. Physicists at Argonne and the University of Chicago showed precisely this failure by a technically difficult experiment.

Work of the U.S. Bureau of Reclamation in 1957

THE U.S. Bureau of Reclamation during the 1957 fiscal year added 160,000 acre-feet of reservoir space for storage of irrigation water and 57MW of hydro-electric generating capacity in multi-purpose dams in the West, according to the Bureau's annual report. Progress was also maintained on other construction work which will add 35,000,000 acre-feet of storage capacity in future years. Irrigated farms helped alleviate the plight of drought stricken cattle growers in Texas, New Mexico, and Oklahoma during the first half of the fiscal year 1957; more than 12,000,000 persons used recreational facilities on the Bureau's 140 reservoirs; and important flood control was provided in the Northwest by Reclamation reservoirs.

The report pointed out that while the Bureau of Reclamation is responsible for the overall supervision of the care, operation, and maintenance and replacement of facilities capable of delivering irrigation water to more than 7,500,000 acres of land, most of the facilities are operated by local water users' organisations which have contracted with the U.S. Government for the repayment of a share of the construction costs. During the fiscal year 1957, irrigation distribution facilities serving appoximately 85 per cent of the total irrigable acreage included in Federal Reclamation projects were operated and maintained by water users.

A significant event was the start of construction of the second highest dam in the United States—the 700ft high Glen Canyon dam on the Glen Canyon unit of the Colorado River Storage project in North-central Arizona. Construction was also begun on the high bridge which will span the Colorado River near the downstream toe of the dam. The steel arch bridge will be the highest and second longest of its kind in the United States. Work was also begun on the new Government community of Page, Arizona.

Facilities of the Bureau now are available to provide water to 7,658,801 acres of irrigable land, representing more than one-fourth of the total irrigated land in the seventeen western states. These facilities include 140 storage dams and reservoirs, 106 diversion dams, 24,400 miles of canals and laterals and 7800 miles of drains. The irrigation facilities in Reclamation Region Five, embracing the States of Texas, New Mexico and Oklahoma, contributed substantially to the saving of the basic breeding herds of cattle threatened with starvation by the severe drought which ravaged the adjacent ranges. The irrigated farms maintained nearly 1,000,000 head of cattle and more than 250,000 head of sheep. In addition, these farms provided sufficient feed to produce 371 million pounds of beef.

Although the snow pack in the Columbia River Basin was nearly normal, sustained high temperatures in April and May resulted in unusually high rates of flow in some areas. The operation of Bureau reservoirs in Region One—Washington, Oregon, Idaho and western Montana—resulted in substantial reductions in downstream flows, particularly on the Upper Snake, the Boise and the Payette rivers in Idaho, the Owyhee and Malheur in Oregon, and the Flathead River in Montana. Storage in the Hungry Horse reservoir in Montana and Lake Roosevelt in Washington reduced the peak flow on the Lower Columbia River by more than 100,000 cusecs and reduced the river stage at the Dalles, Oregon, approximately 2·5ft. In utilising to the greatest extent the water storage at multi-purpose reservoirs, the Bureau of Reclamation has constructed thirty-six power stations with an installed nameplate capacity of 5,031,550kW. In addition, the Bureau now markets the power generated at five power stations constructed by the Corps of Engineers and the International Boundary and Water Commission, with a total nameplate capacity of 776,500kW. The sale of electric power by the Bureau during the year aggregated 25,654,251,471 kWh, with revenues from sales totalling 60,153,473 dollars. During the fiscal year, the installed capacity of hydro-electric power stations at Bureau of Reclamation multi-purpose projects and at projects for which the Bureau is responsible with regard to power distribution, increased 237MW over 1956. The increase included 57MW in units 2 and 3 of the Palisades project in Idaho, 80MW at the Garrison dam, and 100MW at the Gavins Point power station on the Missouri River Basin project. At the end of the year, the Bureau had under construction ten power stations which will have an ultimate installed nameplate capacity of 1120MW.

New Radiation Exposure Limits

THE U.S. Atomic Energy Commission has approved for use in its facilities and those of its contractors new maximum permissible radiation exposures recommended by the National Committee on Radiation Protection and Measurement. No appreciable modification of the Commission's present radiological safety practices will be required as a result of the new radiation exposure standards. In actual practice, the radiation exposure of nearly all of the workers in Commission facilities has been below both the new and the old levels recommended by the N.C.R.P.M. Such adjustments in present safety practices as are required will be made as soon as practicable.

Most of the limits apply to occupational exposures received by workers in areas where radiation levels are monitored and controlled. A basic revision in the radiation standards recommended is the inclusion of a new provision to limit the total radiation dose any individual may accumulate beyond the age of eighteen to an average of 5 rems per year and not more than 15 rems in any year. (A rem, "röntgen equivalent man," is a radiation dose of any ionising radiation estimated to produce a biological effect equivalent to that produced by one röntgen of X-rays.) The N.C.R.P.M. pointed out in connection with the new provision that "changes in the accumulated maximum permissible dose are not the result of positive evidence of damage due to the use of earlier permissible dose levels, but rather are based on the desire to bring the maximum permissible dose into accord with the trends of scientific opinion." Another basic revision in the N.C.R.P.M. recommendations occurs in the permissible radiation levels for internal emitters, i.e. radioactive substances that tend to get into and remain in the human body. In controlled areas, the maximum permissible concentrations in air and water of radioactive substances that tend either to be distributed evenly throughout the body or to be concentrated near the gonads has been reduced to one-third of the values previously specified for occupational exposures to such radioactive substances. The maximum permissible concentrations of radioactive substances that tend to be concentrated in single organs other than the gonads, such as strontium-90 in the bones, remain at the previously recommended levels. For individuals outside of controlled areas, the maximum permissible concentration continues to be one-tenth of the recommended permissible exposures for radiation workers.

In addition to these occupational exposure limits, the N.C.R.P.M. made the following recommendation regarding exposures to the whole population: "The maximum permissible dose to the gonads for the population of the United States as a whole from all sources of radiation, including medical and other man-made sources, and background, shall not exceed 14,000,000 rems per million of population over the period from conception up to age thirty, and one-third that amount in each decade thereafter. Averaging should be done for the population group in which cross-breeding may be expected." The Commission is in accord with the philosophy expressed in this recommendation. The Commission exercises control over the exposures resulting from its own operations and those of its licensees, but does not control exposures which the public may receive from other sources of ionising radiation. Therefore, the Commission has adopted the requirement that its industrial operations must not release any radiation which might be expected to expose members of the populace to an average whole body dosage exceeding 0·5 rem per year or an average concentration of radioactive material exceeding one-tenth of the maximum permissible concentrations for occupational exposures. This requirement will have the effect of limiting exposures to the public from Commission operations to one-tenth of the dosages allowed atomic energy workers. This exposure limit for the public is in accord with a determination of the N.C.R.P.M. that, if persons outside of controlled areas, but exposed to radiation from a controlled area, are assumed to receive yearly an average *per capita* dose of 0·5 rem, the total dose to the whole population from man-made radiations is not likely to exceed 10,000,000 rems per million of population up to age thirty.

Hydrogen-Induced Failure of Steels

DELAYED brittle failure of high-strength steel has become increasingly important, particularly in electroplated aircraft parts, with the trend toward use of higher-strength-level steels. Three principal observations have been made about these failures: (1) there is a time delay, after the parts have been subjected to load, before failure occurs; (2) failure usually occurs at loads well below the design limit, and (3) hydrogen in excess of the residue from the steel-making process is generally necessary for failure to occur. The excess hydrogen is usually absorbed by the steel during pickling or electroplating.

An investigation at Battelle Institute of the causes of such failure was conducted by C. R. Simcoe, A. R. Elsea and E. R. Slaughter (now with General Electric Company). The study had as its aim the determination of the basic mechanism for such failure, and led to the following conclusions:—(1) Delayed brittle failures can be produced easily in unnotched tensile bars if the specimens are continually charged with hydrogen while under sustained loads. (2) The ultimate tensile strength appears to be the most important metallurgical variable in delayed brittle failure. (3) There is a minimum stress for producing a failure; at stresses higher than this minimum the time for failure depends on the applied stress. (4) The minimum stress for failure and delay times are functions of the ultimate tensile strength, both decrease with increasing strength level. (5) Both the minimum stress for failure and the delay times at higher stresses are insensitive to variations in composition and structure of the steel as the latter affect the ultimate tensile strength. (6) A qualitative relationship has been established between hydrogen content, ultimate tensile strength, applied stress, and time required for delayed brittle failures.

Tellurium Semi-Conductors

RECENT work on tellurium-based semi-conducting materials suggests that they may be of use in rectifiers, solar batteries and in refrigeration. To obtain a better understanding of such materials and their potentialities, tellurium compounds of bismuth, antimony, arsenic, silver, copper, magnesium, cadmium and indium are under scrutiny at Battelle Institute, Columbus, Ohio. These studies are sponsored by the Tellurium Development Committee,* and the aim is to discover means of achieving high purity compounds and to establish more precisely the physical, chemical and electrical characteristics of such highly purified compounds. One interesting effect that is being investigated by H. L. Goering and T. C. Harman is the cooling that takes place when an electric current is passed through a specially prepared element of bismuth telluride. They point out that bismuth telluride has a cooling capacity, theoretically great enough, if a number of these elements are used together, to liquefy air directly without compression.

* On the Tellurium Development Committee are representatives of Kennecott Copper Corporation, The Anaconda Company, U.S. Smelting, Refining and Mining Company, Phelps Dodge Refining Corporation, Noranda Mines, Ltd., The American Metal Company, Ltd., and Cerro de Pasco Corporation.

Personal and Business

Appointments

MR. NORMAN F. BRAND has been appointed a director of Heyes and Co., Ltd.

MR. T. H. WEST has been appointed press relations officer to E.M.I. Electronics, Ltd.

MR. J. A. AKED, M.I.E.E., has joined A. Reyrolle and Co., Ltd., as its manager in Scotland.

MR. R. A. S. LOMAX, A.M.I.Mech.E., has been appointed a director of Ashwell and Nesbit, Ltd.

MR. S. G. MEDCRAFT, London sales representative of Fielding and Platt, Ltd., has been appointed sales manager.

MR. A. W. KIRTON has been appointed technical representative in the south west area of British Monorail, Ltd.

CLAYTON DEWANDRE COMPANY, Ltd., has announced that Mr. S. C. Tapley and Mr. I. J. H. Richardson, A.M.I.Mech.E., have been appointed joint assistant general managers.

MR. F. H. WHITAKER has been appointed to succeed Mr. W. E. Knox as director of the administration division of the Exports Credits Guarantee Department. Mr. Knox has retired.

THE BOARD OF TRADE has announced that the President has appointed Mr. Gordon Grant, an Under-Secretary of the Board, to be Comptroller-General of Patents, Designs and Trade Marks, with effect from March 3.

THE CENTRAL ELECTRICITY GENERATING BOARD has announced that Mr. F. J. Lane, M.I.E.E., chief transmission engineer, has relinquished his post and has joined the partnership of Messrs. Preece, Cardew and Rider, consulting engineers.

SMALL ELECTRIC MOTORS, Ltd., has announced the following appointments :—Mr. G. L. Brownson, M.I.E.E., technical director and chief engineer ; Mr. K. H. Harding, sales director, and Mr. J. A. Wilson, A.M.I.E.E., works manager.

THE BRITISH BROADCASTING CORPORATION announces the appointment of Mr. W. R. Fletcher, A.M.I.E.E., as regional engineer, North Region, in succession to Mr. B. H. Vernon, who has retired owing to ill health after nearly thirty-five years' service with the corporation.

THE AIRCRAFT MANUFACTURING COMPANY, Ltd., has announced that its board of directors is constituted as follows :—Mr. W. E. Nixon, chairman ; Mr. Richard Fairey, deputy chairman ; Mr. A. F. Burke, managing director ; Mr. C. P. M. Hunting, Mr. A. S. Kennedy, Mr. F. E. N. St. Barbe, and Mr. W. A. Summers.

ASSOCIATED BRITISH ENGINEERING, Ltd., announces that Mr. Allen A. Scaife, M.I.Mar.E., A.M.I.N.A., has been appointed managing director of H. Widdop and Co., Ltd., in succession to Mr. J. T. MacLeod. Mr. MacLeod is retiring from his executive position for health reasons, but will remain a director and will continue to be available to the company as a general consultant.

LLOYD'S REGISTER OF SHIPPING has announced that Mr. D. Gray, an electrical engineer surveyor on the chief engineer surveyor's staff at headquarters, has been appointed to succeed the late Mr. G. Auterson as the Society's principal electrical engineer surveyor. Mr. W. T. Mathieson, senior surveyor at Bilbao, has been appointed to succeed the late Mr. B. P. Fielden as the Society's principal surveyor for Australia.

Business Announcements

SMAIL SONS AND CO., Ltd., has moved to 21–23, India Street, Glasgow, C.2.

EDWARD SANDEMAN, KENNARD AND PARTNERS have transferred to new offices at 171, Victoria Street, Westminster, London, S.W.1 (telephone, Victoria 0612/3).

"GOODENOUGH" ENGINEERING GROUP has announced the opening of its London offices at 112, Jermyn Street, London, S.W.1 (telephone, Trafalgar 2663/5).

WILD-BARFIELD ELECTRIC FURNACES, Ltd., states that, as from March 1, the address of its Midlands office will be 71, Broad Street, Birmingham, 15 (telephone, Midland 7232).

THE M.A. HANNA COMPANY OF CLEVELAND, Ohio, through its subsidiary company, Hanna Coal and Ore Corporation, has acquired, together with Leo Model, of New York, and Associates, the controlling interest in the British company St. John D'El Rey Mining Company, Ltd.

VERE ENGINEERING COMPANY, Ltd., 3, Vere Street, Oxford Street, London, W.1, states that with effect from March 1, the company's name will be changed to Bartrev Board Company, Ltd.

SILENTBLOC, Ltd., and ANDRE RUBBER COMPANY, Ltd., have jointly announced that for health reasons Mr. P. A. J. Linforth, their Midland area manager, has retired. Mr. F. J. White has been appointed as his successor.

THE BRITISH ALUMINIUM COMPANY, Ltd., states that on Tuesday, March 25, its Manchester branch office will be transferred from 46, Fountain Street, Manchester, 2, to Woolwich House, 59–61, Mosley Street, Manchester, 2 (telephone, Central 2331).

BROWNING STREET INDUSTRIES, Ltd., Browning Street, Birmingham, 16, states that it has opened a showroom for displaying the combined products of its four subsidiaries, W. T. French and Son, Carpenter and Allen, G. and W. Purser, and Ladbrook Stampings.

HERBERT MORRIS, Ltd., and BROWN, LENOX AND CO. (LONDON), Ltd., have announced the formation of a joint company which will begin operations at Millwall, E.14, on April 1, and will continue the work of the existing lifting gear department of Brown Lenox and take over the spares and servicing organisation for Morris equipment in the area.

Contracts

JAMES MILLER AND PARTNERS, Ltd., has been awarded a contract by the Secretary of State for Scotland for the construction of a new bridge, including approaches, over the River Avon at Linlithgow Bridge, to carry traffic on the London–Edinburgh–Thurso trunk road (A9). The new bridge, which will replace the existing narrow and poorly aligned structure, will have a 30ft carriageway and two 10ft footpaths. Messrs. F. A. Macdonald and Partners are the consulting engineers. It is estimated that the scheme, which will take about twenty-one months to complete, will cost £160,000.

THE BRITISH TRANSPORT COMMISSION announces that an order has been placed with British Railways workshops at Swindon for the construction of thirty main line 2000 h.p. diesel-hydraulic locomotives for use in the Western Region. These locomotives will undertake the heaviest passenger and freight working between London and the West of England and will have a BB wheel arrangement. Contracts have been placed with Brush Traction, Ltd., Loughborough, for the supply of the Maybach diesel engines, and with J. Stone and Co. (Deptford), Ltd., London, for the Mekydro transmissions for the locomotives, and a contract for the supply of the electric control equipments has been placed with British Brown Boveri, Ltd., London.

Miscellanea

NEW BUILDING MATERIALS.—The Building Centre, in association with the Birmingham and Five Counties Architectural Association, is holding an exhibition of samples of some "Recent New Building Materials" in the Engineering Centre, Stephenson Place, Birmingham, 2, from Tuesday to Saturday, March 25 to 29. It is hoped to show about forty or fifty new products which have come on to the market in recent months.

FLAMEPROOF TREATMENT FOR FIBREBOARD.—Synthetic building boards of various kinds are now widely used in building construction. One of their disadvantages—that of fire risk—can now be eliminated according to claims made by Hickson's Timber Impregnation Company (G.B.), Ltd., Castleford, Yorks. This company has introduced a "pressure flameproofing" treatment with "Pyrolith" flame-retardant. The treated board is stated to be in Class I of the B.S. 476 spread of flame rating, according to tests carried out at the Fire Research Station.

METAL CLEANING BY ULTRASONICS.—A process of metal cleaning by ultrasonics combined with a vacuum technique available from the Electro-Chemical Engineering Company, Ltd., Woking, Surrey, was developed by Technochemie of Switzerland. It was at first almost entirely devoted to the small intricate mechanisms, but now it is extended to very large installations which can deal with high production requirements and the cleaning of a considerable mass. The frequencies used are 400 kc/s and 40 kc/s and the transducers are piezo-electric and made of barium titanate. With the vacuum technique it is stated that the removal of air from the solvent makes cavitation far more effective, air pockets are removed from any intricate component, enabling the entire surface to have good solvent/surface contact which is essential for good cleaning.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—A paper entitled "The History and Development of Hydraulic Transmissions for Marine Propulsion" was presented by D. Firth before the North East Coast Institution of Engineers and Shipbuilders on February 21. The paper states that hydraulic transmissions can be divided into two main groups : hydrokinetic and hydrostatic. Both have been in existence for more than half a century, but whereas the hydrokinetic type had an immediate application the hydrostatic transmission has only recently been applied to marine propulsion. The paper surveys this field and discusses contemporary interest in the application of both forms of transmission to marine propulsion and also what use might be made of them in the future.

SMOKE DENSITY INDICATOR.—A simple smoke density indicator, developed by the Fuel Research Station of the Department of Scientific and Industrial Research, is now available from Shandon Scientific Company, Ltd., 6, Cromwell Place, London, S.W.7. It consists of a special glowing element (known as the "Glowring"), placed in the side flue and which is viewed through a column of flue gas from an observation window in the front wall of the flue. The brightness of the "Glowring" can be adjusted, so that it is obscured when the smoke density corresponds with No. 2 shade on the Ringelmann chart. This is the density which, under the Clean Air Act, must not be exceeded. In this equipment, except for the observation window which is easily accessible, there are no mirrors or glasses to be cleaned. The glowing element is self-cleaning as any deposits on it are burnt off.

RAM-JET PERFORMANCE.—A ram-jet test vehicle launched at the Royal Aircraft Establishment's rocket range at Aberporth, West Wales, by the National Gas Turbine Establishment, has flown under power to a height of 70,000ft in 40 seconds. It was accelerated by eight booster motors and in the course of its flight reached Mach=2·3. When its fuel was exhausted at 70,000ft, it coasted to a height of 114,000ft before being destroyed for reasons of range safety. This launch was the most recent of a number which have been made with ram-jet test vehicles designed and developed jointly by the N.G.T.E. and D. Napier and Son, Ltd., over a period of several years, and manufactured by Napier at its Flight Development Establishment, at Luton Airport, Bedfordshire. The vehicle was an improved version of one which set up a height record for its class two years ago. The envelope of previous tests appeared on page 868, December 13, 1957.

TRAINING TECHNICAL TEACHERS.—The three training colleges for technical teachers in Bolton, Huddersfield and London are now engaged in a recruiting campaign in order to obtain suitable candidates for the training courses which begin next September. As explained in the article on page 232 of our issue of February 14, the number of places in technical teacher training colleges is being increased by 60 per cent. Higher rates of grants are to be paid to students in order to attract and encourage candidates of the right calibre. The course of training extends over one academic year. Candidates who wish to train as teachers of engineering should be, generally, between twenty-five and forty-five, have industrial experience and possess at least one of the following :—Degree or other professional qualification ; higher national certificate ; full technological certificate of the City and Guilds of London Institute. Full details of the scheme can be obtained from the Bolton Training College, Manchester Road, Bolton ; Garnett College, 83, New Kent Road, London, S.E.1, and Huddersfield Training College, Queen Street South, Huddersfield.

ROAD TANKER CONSTRUCTION.—It has been drawn to our attention that our article under the above heading on February 14 was in certain respects misleading. The light alloy tanks illustrated were of 2400-gallon capacity, whereas a vehicle of maximum gross weight 14 tons would be able to carry only about 2000 gallons in a steel tanks ; these tanks were to carry industrial solvents of various specific gravities. While the customer for these tanks, namely, Shell, does invariably coat the inner surfaces of steel petrol tanks, partly because the white finish renders inspection much easier, uncoated tanks of mild steel are still used for the carriage of petrol. An exception is aviation gasoline, which is delivered directly into the ready-to-use tank, and always carried in aluminium or coated steel tank ; the uncoated steel tank presents the problem of water separating out of the fuel and sticking to the tank, until a stage is reached at which the water eliminator is presented with an impossibly high water concentration. The light alloy tanks follow Continental practice, consultation with Aluminium Francaise having preceded the design.

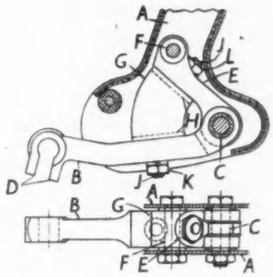
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in Italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

ROAD TRANSPORT

789,906. September 29, 1955.—FRONT WHEEL SUSPENSIONS FOR MOTOR VEHICLES, Aufida A.G., Schinznach-Bad, Switzerland.

The invention relates particularly to suspensions for the front wheels of motor-driven vehicles such as motor-cycles, auto-cycles and motor-scooters. In the drawing, a housing part of a fork is shown which serves for supporting the front wheel of a motor-cycle. In each fork section *A* there is a rocking lever *B* rotatably supported on the pin *C* fixed in the



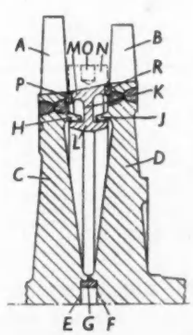
No. 789,906

fork section. The front end of the two rocking levers is formed as a fork *D* in which the spindle of the front wheel is fastened. An abutment *E* is fastened to the pin *C* and to the pin *F*. For the suspension of the rocking lever *B* a buffer element *G* is used which consists of rubber. The buffer element has the form of a section of a ring. At both ends plates *H* are vulcanised to it, to which screw studs *J* are welded. These studs engage at one end through the rocking lever *B* and at the other end through the abutment *E* and are retained by nuts *K* and *L*. The buffer element *G* is stressed in compression in the rotary direction. It is also possible to eliminate the screw studs and to connect the buffer element to the rocking lever and to the abutment by vulcanisation. The fastening by means of the studs *J*, however, provides the possibility of exchanging for buffer elements of different elasticity at any time.—*January* 29, 1958.

GAS TURBINES

790,029. December 1, 1955.—BUILT-UP ROTOR FOR AXIAL FLOW TURBINES, Maschinenfabrik Augsburg-Nürnberg A.G., Stadtbachstrasse 7, Augsburg 2, Germany.

The invention relates to a built-up rotor, particularly for gas turbines, built up from individual mutually centred wheel discs fitted with rotor blades. The drawing shows the two-wheel discs of a two-



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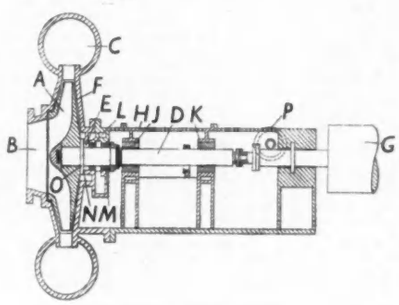
stage exhaust gas turbine, to which the blade rings *A* and *B* are attached by welding and are shown at *C* and *D*, respectively. The discs are provided at the centre with recessed portions *E* and *F*, into which a locating ring *G* is fitted in order to ensure centring. On adjacent sides of adjacent discs and near the periphery are axial annular projections *H* and *J*, which are threaded internally. A co-operating external thread is formed in the internal flange of an I-section ring *K*, the internal flange of the ring being *L* and the external flange *M*. The external flange *M* is first reinforced so that the tools necessary to firmly tighten the threaded ring can be placed in position. The outline of the raised flange is shown in chain-dotted lines. The raised part is *N* and in this part of the flange bores *O* are formed to receive a hook spanner. After the threaded ring *K* has been firmly tightened, the faces of the external flange *M* then bear tightly against the lateral surfaces of the wheel discs *C* and *D* and the raised part *N* of the external flange is removed by turning. The screwed connection is secured by grub screws *P* and *R* in the joints between the faces of the external flange and the wheel discs, the grub screws being disposed at the beginning and end of the rotor blade channels. Modified designs are also shown in the specification.—*January* 29, 1958.

POWER TRANSMISSION

789,680. April 21, 1955.—SHAFT SEALING ARRANGEMENTS, C. A. Parsons and Co., Ltd., Heaton Works, Newcastle upon Tyne, 6. (*Inventors: Andrew Thompson Bowden, Frank Medcalfe and Ronald Sanderson Mathison Kilby.*)

The object of the invention is to provide means enabling shaft seals to receive attention for maintenance and other purposes without the need for reducing the pressure in or evacuating the fluid from the system. As the drawing shows, a blower *A* circulates fluid from space *B* to outlet *C*, both of which are part of a pressurised enclosed system. A drive shaft *D* for the blower passes through opening or outlet *E* in the blower casing *F* and is surrounded for the remainder of its length, between the blower and a prime mover *G* driving it, by a housing *H*, open to atmosphere, in which are mounted bearings



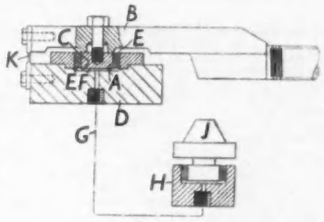
No. 789,680

J and *K*. Along the length of the shaft between outlet *E* from the casing and bearing *J* are shaft sealing arrangements for the prevention of leakage of fluid along the shaft. These sealing arrangements consist of a labyrinth seal *L* and a liquid seal of the thrust collar type, indicated generally at *M*. A supplementary seal *N* is formed between sealing means on a collar *O* of shaft *D* just inside the housing *F* and a sealing face of the housing itself. Gear for moving the shaft towards the right of the drawing in the direction of its axis is shown diagrammatically at *P* and referred to in more detail in the specification.—*January* 29, 1958.

TRANSMISSION OF FORCE

790,291. March 22, 1955.—LEVER SYSTEMS, A. Macklow-Smith, Ltd., 8, Malbrook Road, Putney, London, S.W.15. (*Inventor: Arthur Macklow-Smith.*)

This invention relates to lever systems and particularly to means for supporting a lever so as to allow tilting of the lever relative to its support, as, for example, a fulcrum for a lever or the means by which a force can be applied to a lever. The drawing represents in elevation the arm of a weighing machine embodying a device according to the invention. A metal disc *A* is secured to the lever arm *B* by a screw and is mounted coaxially in a cup-shaped recess *C* in a metal base member *D*. An annular member *E* of rubber joins the periphery of the disc *A* to the periphery of the recess *C*, the rubber being bonded to the metal. The disc is spaced above the bottom of the recess and the space *F* thus formed is filled with liquid. A conduit *G* leads from the bottom of the recess to a similar capsule device *H*, comprising a disc and base member, to which the load *J* to be weighed is applied. Pressure is thus applied to the liquid and transmitted through the disc to the lever



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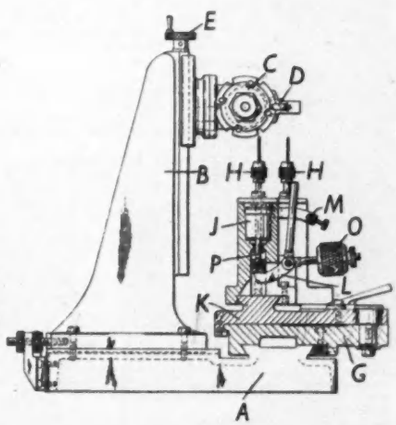
B. The lever is joined to the base member *D* at its end by leaf springs *K* or other known devices, so that the lever can pivot thereabout. The pressure applied to the disc is balanced by a weight which can be slid along the lever in the usual manner. Alternatively, a fixed weight may be used and the pressure on the disc adjusted, by adjusting the load being weighed, to balance the arm. In another form a similar device is used to provide the fulcrum about which a lever pivots. In this case, the arrangement is as shown in the drawing, except that the recess *F* below the disc *A* is sealed—that is, the provision for connection of the conduit *G* is omitted.—*February* 5, 1958.

MACHINE TOOLS

790,229. March 2, 1955.—DRILLING OR LIKE MACHINES, Birfield Tools and Designs, Ltd., formerly known as Toolmaker and Designs (Coventry), Ltd., Bodmin Road, Coventry. (*Inventor: Alfred Holmes.*)

The object of the invention is to provide a drilling machine wherein a number of tool holders are provided to operate in sequence on the workpiece. The drawing shows a drilling machine particularly adapted for use in connection with the drilling of holes of a small diameter in fuel nozzles, has a horizontal bed *A* and a vertical bed *B*. On the vertical bed is slidably mounted an indexing holder or chuck *C* for the workpieces having a spring-controlled catch *D*. This holder can be moved into a predetermined vertical position by adjustment *E*. The vertical bed can be adjusted laterally. On the horizontal bed *A* of the machine is a saddle *G* on which is pivotally mounted a



No. 790,229

slide for chucks or suitable tool holders *H*, which may be rotated by electric or air motors *J*. These tool chucks can be moved in sequence to operate on the work mounted in the holder *C*. A rotary or pivotal movement of the slide *K* on the saddle *G* is controlled by a hand lever *L*, which controls the locating indexing plunger for the slide, and brings the tool holders or chucks *H* into the correct position in sequence in relation to the work holder *G*. The tool holders *H* can be advanced into engagement with the work by the bell-crank lever. An arm attached to the bell-crank lever *L* has adjustably mounted on it a counterweight *O* which provides the necessary thrust on the spindle *P* of the tool holder to advance the drill. The amount of vertical movement allowed to the tool holder *H* is controlled by setting of the adjusting screw *M*.—*February* 5, 1958.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Feb. 28.—COVENTRY BRANCH: Craven Arms, Coventry, Film of 1957 Electrical Engineers' Exhibition, 8.15 p.m.

Mon., March 3.—CENTRAL LONDON BRANCH: White Hall Hotel, London, W.C.1, "The Testing of Electrical Circuits and Apparatus," J. S. Forest, 6.30 p.m. ★ LEEDS BRANCH: Great Northern Hotel, Leeds, "Earth Leakage Protection," J. A. Robbins, 7.30 p.m.

Tues., March 4.—WEST LONDON BRANCH: Windsor Castle Hotel, 134, King Street, Hammersmith, "De-Gaussing—Theory, Design and Operation," W. H. Petrie, 7.30 p.m. ★ OXFORD, READING AND DISTRICTS BRANCH: The University, London Road, Reading, "Education in the Electrical Industry," W. H. Brooks, 7.15 p.m.

Wed., March 5.—GLASGOW BRANCH: Institution of Engineers and Shipbuilders in Scotland, Elmbank Crescent, Glasgow, C.2, "Modern Installation Practice," A. V. Logie, 8 p.m. ★ HALIFAX BRANCH: Crown Hotel, Horton Street, Halifax, "Earth Leakage Protection of Domestic and Similar Installations," J. A. Robbins, 7.45 p.m. ★ MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "N.I.C.E.I.C.," H. F. Smith, 7 p.m.

Thurs., March 6.—SOUTHAMPTON BRANCH: Pilgrim Room, Polygon Hotel, Southampton, "Transatlantic Communications Cable," R. J. Jordan, 8 p.m. ★ SOUTH WEST LONDON BRANCH: "Prince of Wales" Hotel, Wimbledon, London, S.W.19, Film of the Sixth Electrical Engineers' Exhibition, and visit of P. A. Thorogood, 8.30 p.m.

Fri., March 7.—LIVERPOOL AND DISTRICT BRANCH: Liverpool Engineering Society, 9, The Temple, 24, Dale Street, Liverpool, 2, "Through Central Europe," J. G. P. Anderson, 7.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

To-day, Feb. 28.—SOUTH MIDLANDS SECTION: North Gloucestershire Technical College, Cheltenham, "Some Advanced Application on Information Theory," P. H. Blundell, 7 p.m.

Thurs., March 6.—NORTH WESTERN BRANCH: Reynolds Hall, College of Technology, Sackville Street, Manchester, 1, Films, 6.30 p.m.

BRITISH INTERPLANETARY SOCIETY

Sat., March 1.—Tudor Room, Caxton Hall, London, S.W.1, "The Guidance and Control of Long-Range Vehicles," G. A. Whitfield, 6 p.m.

ILLUMINATING ENGINEERING SOCIETY

To-day, Feb. 28.—BIRMINGHAM CENTRE: Regent House, St. Phillip's Place, Colmore Row, Birmingham, Annual General Meeting, 6 p.m.

Wed., March 5.—EDINBURGH CENTRE: Y.M.C.A. Social Room, 14, South St. Andrew Street, Edinburgh, "Open Space Lighting," M. W. Peirce and H. F. Stephenson, 6.15 p.m.

Thurs., March 6.—CARDIFF CENTRE: Demonstration Theatre, South Wales Electricity Board, The Hayes, Cardiff, "The Architect's Approach to Lighting," G. G. Baines, 6 p.m. ★ GLASGOW CENTRE: Lighting Service Bureau of Scotland, 29, St. Vincent Place, Glasgow, C.1, Annual General Meeting; "Open Space Lighting," M. W. Peirce and H. F. Stephenson, 6.30 p.m.

INCORPORATED PLANT ENGINEERS

To-day, Feb. 28.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, "Maintenance of Transport," R. Scarth, 7.30 p.m.

Tues., March 4.—GENERAL MEETING: Royal Society of Arts, John Adam Street, Adelphi, Strand, London, W.C.2, "Plant Engineers in a Changing Britain," L. G. Northcroft, 7 p.m. ★ EDINBURGH BRANCH: 25, Charlotte Square, Edinburgh, Annual General Meeting, 7 p.m. ★ PETERBOROUGH BRANCH: White Lion Hotel, Church Street, Peterborough, "Electronic Control of Machine Tools," N. Milne, 7.30 p.m.

Wed., March 5.—KENT BRANCH: Kings Head Hotel, High Street, Rochester, Annual General Meeting, 7 p.m.; ★ LEICESTER BRANCH: Technical College, Leicester, "Electrostatic Filters," M. Penrose, 7 p.m. ★ SOUTHERN BRANCH: Polygon Hotel, Southampton, Annual General Meeting, 7.30 p.m.

INSTITUTE OF FUEL

Mon., March 3.—NORTH EASTERN SECTION: Chemistry Lecture Theatre, King's College, Newcastle upon Tyne, "The Control of Added Moisture in Coal," D. A. Hall, 6.30 p.m.

Thurs., March 6.—BRISTOL AREA: The University, Bristol, "Recent Developments in the Zinc Industry in the U.K.," S. W. K. Morgan, 6.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., March 3.—MERSEYSIDE AND NORTH WESTERN SECTION: Liverpool Engineering Society, The Temple, Dale Street, Liverpool, "Heat Balance Calculations and their Use in the Installation Design of Steam Turbine Merchant Ship Propulsion Machinery," E. Tyrrell, 6 p.m.

Tues., March 4.—NORTHERN IRELAND PANEL: College of Technology, Belfast, "Corrosion Control in Tankers," A. Logan, 7.30 p.m.

Fri., March 7.—SCOTTISH SECTION: Robert Gordon's College, Aberdeen, "Nuclear Steam Propulsion for Merchant Ships," W. R. Wootton, 7.45 p.m.

INSTITUTE OF METALS

Tues., March 4.—OXFORD LOCAL SECTION: Cadena Café, Cornmarket Street, Oxford, "Nucleation and the Cast Structure," V. Kondic, 7 p.m. ★ SOUTH WALES LOCAL SECTION: Department of Metallurgy, University College, Singleton Park, Swansea, "Metals for High Temperature Service," W. Betteridge, 6.30 p.m.

Thurs., March 6.—BIRMINGHAM LOCAL SECTION: College of Technology, Gosta Green, Birmingham, "The Metallurgy of Steel for Deep Drawing and Pressing," A. J. K. Honeyman, 6.30 p.m. ★ LONDON LOCAL SECTION: 17, Belgrave Square, London, S.W.1, "High Purity Iron," B. E. Hopkins, 6.30 p.m.

INSTITUTE OF REFRIGERATION

Thurs., March 6.—JUNIOR INSTITUTION OF ENGINEERS, Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Modern Trends in Cold Store Design and Operation in France," P. Vidal, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., March 3.—SCOTTISH CENTRE: Institution of Engineers and Shipbuilders, Elmbank Crescent, Glasgow, "The Manumatic Gearbox," P. J. Holman, 7.30 p.m.

Tues., March 4.—EASTERN CENTRE: The Canteen, Eastern Counties Omnibus Company, Ltd., Norwich, "Road and Rig Testing of Prototype Road Transport Vehicles and their Components," J. H. Alden, 7 p.m. ★ MIDLANDS CENTRE: Visit to Stanlow Oil Refinery, 8.20 a.m.

Wed., March 5.—EAST MIDLANDS CENTRE: Mechanics' Institute, Nottingham, "Research on the Testing and Performance of Commercial Vehicle Brakes," H. J. Starks, 7.30 p.m.

Thurs., March 6.—WEST REGIONAL CENTRE: Liverpool Architectural Society's Rooms, Bluecoat Chambers, School Lane, Liverpool, 1, Discussion Group, 7.30 p.m. ★ WESTERN CENTRE: Royal Hotel, Bristol, "The Work of the Motor Industry Research Association," J. G. Giles, 7 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., March 4.—LONDON BRANCH: Hoare Memorial Hall, Church House, London, S.W.1, Spring Meeting, 9.30 p.m.

Wed., March 5.—MIDLANDS BRANCH: Midland Institute, Paradise Street, Birmingham, "The Flow of Granular Materials Through Orifices," R. L. Brown, 6.30 p.m.

Thurs., March 6.—EAST MIDLAND GRADUATES AND STUDENTS' CENTRE: Main Lecture Theatre, College of Technology, Loughborough, Annual General Meeting; "Economic Aspect of Scale-Up," R. G. Dickerson, 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., March 4.—Great George Street, Westminster, London, S.W.1, "Reconstruction of Whitby Fish Quay," G. W. Rooke and F. L. Terrett, 5.30 p.m.

Thurs., March 6.—NORTH WESTERN ASSOCIATION: Engineers' Club, 17, Albert Square, Manchester, "The Use of the Computer in Engineering Analysis," B. M. Evans, 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, Feb. 28.—NORTH EASTERN GRADUATE AND STUDENT SECTION: Grand Hotel, Barras Bridge, Newcastle upon Tyne, Problems Night, 6.30 p.m.

Mon., March 3.—LONDON GRADUATES AND STUDENTS' SECTION: Savoy Place, London, W.C.2, "The Application of Nuclear Energy to Power Production," T. R. Puzey, 6.30 p.m. ★ EAST ANGLIAN SUB-CENTRE: Crown and Anchor Hotel, Ipswich, "The B.B.C. Sound Broadcasting on Very-High Frequencies," E. W. Hayes and H. Page, 6 p.m. ★ MERSEY AND NORTH WALES CENTRE: Royal Institution, Colquitt Street, Liverpool, "Advanced Types of Power Reactors," J. V. Dunworth, 6.30 p.m. ★ NORTH EASTERN RADIO AND MEASUREMENTS GROUP: King's College, Newcastle upon Tyne, "Radio in Air-Sea Rescue," G. W. Hosie, D. Kerr and W. Kiryluk, 6.15 p.m. ★ NORTH STAFFORDSHIRE SUB-CENTRE: Town Hall, Hanley, "D.C. Winder Drives Using Mercury-Arc Rectifier/Inverters," L. Abram, J. P. McBreen and J. Sherlock, 7 p.m. ★ MAIDSTONE DISTRICT BRANCH: Medway College of Technology, Maidstone Road, Chatham, "Electronics and Automation: Some Industrial Applications," H. A. Thomas, 6.30 p.m. ★ SOUTH MIDLAND CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham, "Pulses and Transformers," G. F. Gare; "Electrical Drives for High Speed Rod Mills," J. I. Jones, and "Methods of Producing High Frequency Power by Rotating Machines," B. James, 6 p.m.

Tues., March 4.—NORTH WESTERN CENTRE: Free Trade Hall, Manchester, "The Electrification of the British Railways," by the late G. H. Fletcher, to be read by R. Ledger, 7 p.m. ★ SOUTH EAST SCOTLAND SUB-CENTRE: Carlton Hotel, North Bridge, Edinburgh, "The Digital Computer Applied to the Design of Large Power Transformers," W. A. Sharpley and J. V. Oldfield, 7 p.m. ★ EDUCATION DISCUSSION CIRCLE: Savoy Place, London, W.C.2, "Some Impressions of Technical and Industrial Training in the United States," opened by K. R. Sturley, 6 p.m.

Wed., March 5.—TEES-SIDE SUB-CENTRE: Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, "Earthing of Low and Medium-Voltage Distribution Systems and Equipment," F. Mather, 6.30 p.m. ★ NORTH MIDLAND CENTRE: Town Hall, Barnsley, Joint Meeting with Sheffield Sub-Centre, "Earth Electrode Systems for Large Electric Stations," J. D. Humphries, 7 p.m. ★ NORTH LANCASHIRE SUB-CENTRE: N.W.E.B., Demonstration Theatre, Finckle Street, Kendal, "The Measurement of Earth-Loop Resistance," G. F. Tagg, 7.15 p.m. ★ SOUTH WEST SCOTLAND SUB-CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "The Digital Computer Applied to the Design of Large Power Transformers," W. A. Sharpley and J. V. Oldfield, 7 p.m. ★ SOUTHERN CENTRE: The University, Southampton, "Electrical Floor Warming," J. W. Moule and W. M. Stevenson, 6.30 p.m. ★ LONDON GRADUATES AND STUDENTS' SECTION: Visit to Long Distance Telephone Exchange, Faraday Building, London, E.C.4, 2 p.m.

Thurs., March 6.—ORDINARY MEETING: Savoy Place, London, W.C.2, "Results of Full-Scale Stability Tests on the British 132kV Grid System," F. Busemann and W. Casson; "The Organisation for Large-Scale Grid System Tests," F. H. Last, E. Mills and N. D. Norris, 5.30 p.m. ★ MERSEY AND NORTH WALES CENTRE: Philharmonic Hall, Liverpool, "The Electrification of the British Railways," by the late G. H. Fletcher, to be read by R. Ledger, 6.45 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Mon., March 10.—Northern Architectural Association Hall, 6, Higham Place, Newcastle upon Tyne, "Design and Construction of the St. Michel Reflector," D. E. Walker, 7.15 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Tues., March 4.—EAST ANGLIA BRANCH: Assembly House, Norwich, "Dewatering," L. F. Offer, 6.30 p.m.

Thurs., March 6.—SOUTH WEST BRANCH: Grammar School, Goole, "Practical and Theoretical Approaches to Highway Problems," N. D. B. Barnett, 7 p.m.

Fri., March 7.—LONDON BRANCH: Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Off-Street Parking," R. Chinn, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Feb. 28.—LONDON BRANCH: 1, Birdcage Walk, Westminster, London, S.W.1, "Design and Construction of the Main Compressor for the 8ft × 8ft High-Speed Wind Tunnel at R.A.E., Bedford," L. J. Cheshire, J. Y. G. Evans, W. A. Goodsell and P. H. W. Wolff, 6 p.m. ★ SCOTTISH BRANCH: Technical College, Dundee, "Machinery in Cross-Channel Passenger Ships," E. L. Denny, 7.30 p.m.

Tues., March 4.—APPLIED MECHANICS GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion, "Mathematics in Mechanical Engineering," 6 p.m.

Wed., March 5.—EAST MIDLANDS BRANCH: Room C.4, Engineering Building, The University, Nottingham, Discussion on "The Problems Facing the Engineering Designer," 7.15 p.m. ★ YORKSHIRE BRANCH: Visit to Steel, Peech and Tozer Branch of United Steel Companies, Ltd., Rotherham, 2.30 p.m.; Grand Hotel, Sheffield, "The Economics of Plant Renewal and Replacement," C. W. Griffiths, 6.30 p.m. ★ NORTH EASTERN GRADUATES' SECTION: Lecture Theatre, Rutherford Technical College, Northumberland Road, Newcastle upon Tyne, "Photography in Industry," A. Horder, 7 p.m.

Thurs., March 6.—EDUCATION GROUP DISCUSSION: 1, Birdcage Walk, Westminster, London, S.W.1, "How Should Liberal Studies be Dealt With in Technical Colleges?" 6 p.m. ★ NORTH WESTERN BRANCH: Engineers' Club, Albert Square, Manchester, "Design of Pressure Systems and Allied Mechanical Plant for Gas-Cooled Reactors," G. Brown, 6.45 p.m. ★ SCOTTISH BRANCH: Royal College of Science and Technology, Glasgow, "A Review of Applications of Radioisotopes to Engineering," J. L. Putman, 7.30 p.m. ★ EAST MIDLANDS GRADUATES' SECTION: Technical College, Shakespeare Street, Nottingham, "Rolling Bearings," C. S. Clarke, 7.15 p.m. ★ NORTH EASTERN GRADUATES' SECTION: Cleveland Scientific and Technical Institute, Middlesbrough, "Photography in Industry," A. Horder, 7 p.m. ★ SOUTHERN GRADUATES' SECTION: Technical College, Guildford, Film Show, 7 p.m. ★ WESTERN GRADUATES' SECTION: Swindon Engineering Society's Rooms, 2, Emlyn Square, Swindon, "Management Consultancy," D. M. Jack, 7.30 p.m. ★ YORKSHIRE GRADUATES' SECTION: Grand Hotel, Sheffield, Chairman's Address, "Recent Experiences in America," 6.30 p.m.

Fri., March 7.—LONDON BRANCH: 1, Birdcage Walk, Westminster, London, S.W.1, Ordinary Meeting in conjunction with the Steam Group, "Modern Reheat Practice in Steam Power Stations," F. H. S. Brown and J. W. H. Dore, 6 p.m. ★ SCOTTISH BRANCH: North British Hotel, Edinburgh, "A Review of Applications of Radioisotopes to Engineering," J. L. Putman, 6.30 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Tues., March 4.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, "The Use of Rectangular Loop Magnetic Material in Electronic Switching Circuits," E. L. Bubb and K. R. Wilderspin, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

To-day, Feb. 28.—DERBY SECTION: College of Art, Derby, "Nuclear Power and the Production Engineer," I. Munro, 7 p.m. ★ CARDIFF SECTION: South Wales Institute of Engineers, Park Place, Cardiff, "The Use of Time-Lapse Photography in Work Study," A. G. Northcott, 7 p.m.

Sat., March 1.—LEEDS GRADUATE SECTION: Visit to Central Electricity Authority, Yorkshire Division, Leeds, 10 a.m. ★ WOLVERHAMPTON GRADUATE SECTION: Visit to Mitchells and Butlers, Ltd., Cape Hill Brewery, Birmingham, 9.45 a.m.

Wed., March 5.—WOLVERHAMPTON SECTION: College of Technology, Wolverhampton, "Computer Control of Machine Tools," O. S. Puckle, 7.15 p.m. ★ NOTTINGHAM SECTION: Victoria Station Hotel, Nottingham, Annual General Meeting; Films, 7 p.m. ★ LONDON GRADUATE SECTION: Institution of Production Engineers, 10, Chesterfield Street, London, W.1, Annual General Meeting; Films, 7.15 p.m. ★ WESTERN SECTION: Small Lecture Theatre, Engineering Faculty, The University, Bristol, "Brewing and Bottling," L. Worssam, 7.15 p.m. ★ EDINBURGH SECTION: North British Hotel, Princes Street, Edinburgh, "The Case for Materials Handling," F. H. Eccersley; Annual General Meeting, 7.30 p.m.

Thurs., March 6.—LUTON SECTION: Small Assembly Room, Town Hall, Luton, Discussion Evening and Annual General Meeting, 7.30 p.m. ★ READING SECTION: Great Western Hotel, Reading, Annual General Meeting; Film, "Copy Turning and Its Development," 7.30 p.m. ★ GLASGOW SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, Annual General Meeting, 7.30 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., March 3.—BURTON-ON-TRENT SECTION: Midland Hotel, Station Street, Burton-on-Trent, "Modern Developments in the Use of Nylon in the Rubber Industry," J. Buchan, 7.15 p.m. ★ LEICESTER SECTION: Grand Hotel, Leicester, "The Special Purpose Co-Polymers of Butadiene," C. L. Bryant, 6.45 p.m. ★ PRESTON SECTION: Bull and Royal Hotel, Church Street, Preston, "The Production of Plastic Film and Plastic Coated Fabrics," A. D. Clarke, 7.15 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Feb. 28.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, "Some Notes on the Use of High Preload Bolts in the United Kingdom," F. M. Easton, E. M. Lewis and D. T. Wright, 6 p.m.

Tues., March 4.—NORTHERN COUNTIES BRANCH: Cleveland Scientific and Technical Institution, Middlesbrough, "The Use of Gunite as a Structural Material," T. Whitley Moran, 6.30 p.m. ★ SCOTTISH BRANCH: Institution of Engineers and Shipbuilders, Glasgow, "Some Notes on the Use of High Preload Bolts in the United Kingdom," F. M. Easton, E. M. Lewis and D. T. Wright, 7 p.m.

Wed., March 5.—NORTHERN COUNTIES BRANCH: Neville Hall, Newcastle, "The Use of Gunite as a Structural Material," T. Whitley Moran, 6.30 p.m.

Fri., March 7.—MIDLAND COUNTIES BRANCH GRADUATES AND STUDENTS' SECTION: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, "Practical Aspects of Soil Mechanics and Site Investigation," K. H. Head, 6.30 p.m.

INSTITUTION OF WORKS MANAGERS

To-day, Feb. 28.—NOTTS AND DERBY BRANCH: Grandstand Hotel, Nottingham Road, Derby, Films, 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Feb. 28.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "A Fully Educated Engineer," W. Abbott, 7 p.m.

Wed., March 5.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, Presidential Address, "The Origin and Function of R.E.M.E.," W. A. Lord, 7 p.m.

Fri., March 7.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Films, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

To-day, Feb. 28.—The University, Manchester, "Brushless Variable Speed Induction Motors," F. C. Williams, 6.45 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., March 7.—Lecture Theatre, Mining Institute, Newcastle upon Tyne, "Experimental Investigations on Natural Circulation in Watertube Boilers," A. M. Laird and A. S. T. Thomson, 6.15 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., March 4.—NORTH WESTERN BRANCH: College of Technology, Sackville Street, Manchester, "Design and Construction of Hangars at Helsinki," J. N. Lowe, 6.45 p.m. ★ MIDLAND COUNTIES BRANCH: Birmingham and Midland Institute, Paradise Street, Birmingham, "Grouted Concrete Construction," S. Champion and L. Truman Davies, 6 p.m.

Wed., March 5.—NORTH WESTERN BRANCH: Liverpool Engineering Society, The Temple, 24, Dale Street, Liverpool, "Design and Construction of Hangars at Helsinki," J. N. Lowe, 6.30 p.m.

ROYAL AERONAUTICAL SOCIETY

Wed., March 5.—L'Aero Club de France, No. 6, Rue Galilee, Paris, 16, eleventh Louis Bleriot Lecture, "The Future of Aeronautical Research," W. J. Duncan, 5 p.m.

ROYAL INSTITUTION

Thurs., March 6.—21, Albemarle Street, London, W.1, "Aero-Thermodynamics," W. R. Hawthorne, 9 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., March 3.—ORDINARY GENERAL MEETING: 12, Great George Street, London, S.W.1, "The Protection of Structures Against Subsidence," K. Wardell, 5.45 p.m.

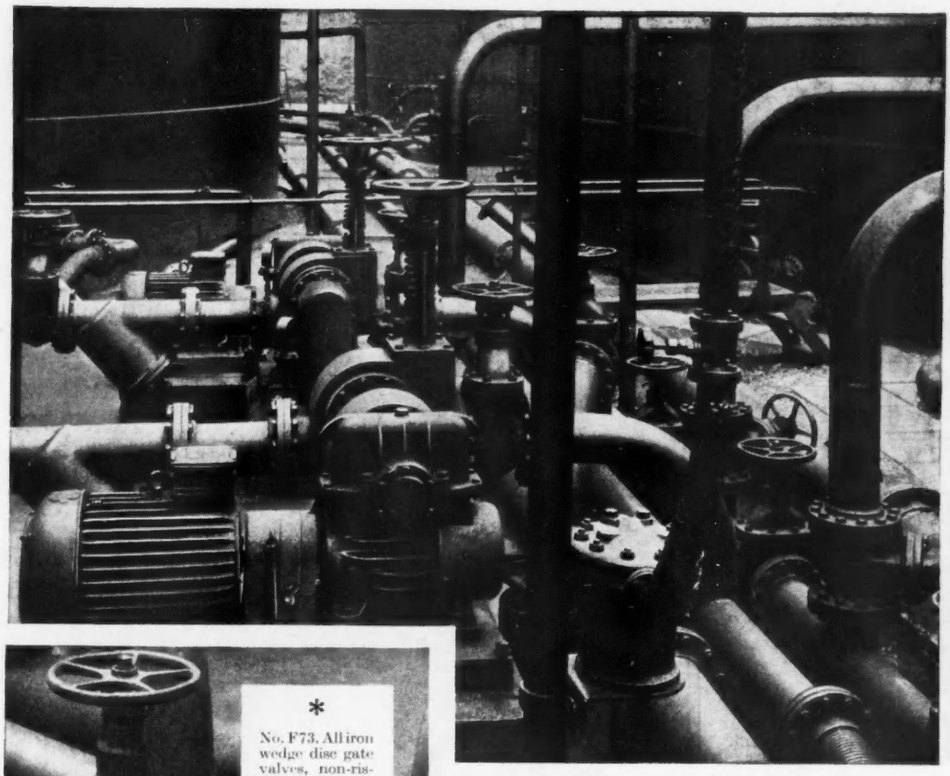
SHEFFIELD METALLURGICAL ASSOCIATION

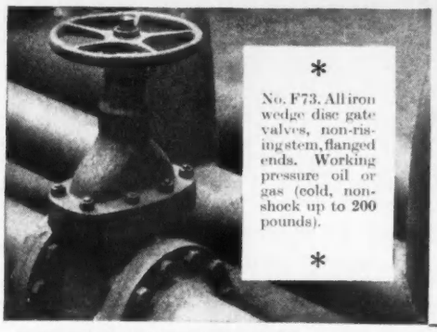
Tues., March 4.—B.I.S.R.A., Hoyle Street, Sheffield, "The Application of Stable and Radioactive Isotopes in Analytical Chemistry," A. A. Smales, 7 p.m.

Advanced Engineering Courses

Basic Principles of Nuclear Engineering. DEPARTMENT OF EXTRA-MURAL STUDIES, THE UNIVERSITY, Liverpool. Easter Vacation Course, April 13 to 19. Course of sixteen lectures, together with demonstrations, discussions, and a tour of the work at the University Nuclear Physics Laboratory. Fee £15 15s. residential. £10 non-residential.

Operational Research. UNIVERSITY OF BIRMINGHAM, INSTITUTE FOR ENGINEERING PRODUCTION, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham. Residential Executive Course, from 9.30 a.m. Monday, March 17, until 4 p.m. Friday, March 28. Fee £50, non-residential £40.





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No. F73. All iron wedge disc gate valves, non-rising stem, flanged ends. Working pressure oil or gas (cold, non-shock up to 200 pounds).

*

Once again, valves by Crane

At the tar works of the South Eastern Gas Board are six, one million gallon tanks used for the storage of crude tar and its products. Here is shown a twin-pump unit coupled through Crane valves to 'the million gallon storage'. In fact all the materials which enter or leave these tanks pass through Crane valves — all iron wedge gate valves with non-rising stem. Yet another twin-pump unit in the same works handles refined tar through similar cast iron valves at about 180° F.; the same unit pumps Coal Tar Fuel to barges berthed at the Board's wharf on the Thames. Once again all valves function faultlessly—thanks to Crane!

CRANE VALVES OF BRONZE, CAST IRON & CAST STEEL

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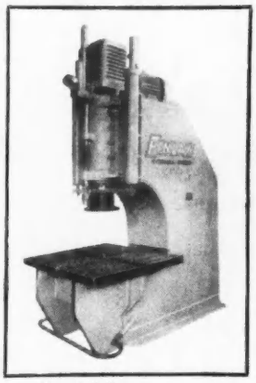
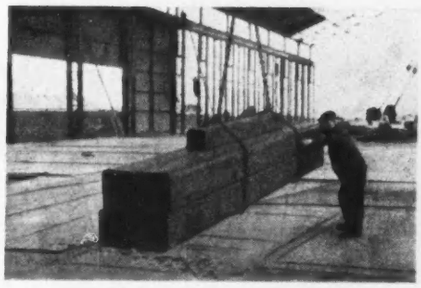
FINLAY PRESSES
for SHIP CONSTRUCTION

Finlay V120 Hydraulic Press forming vent cowls in a shipyard.

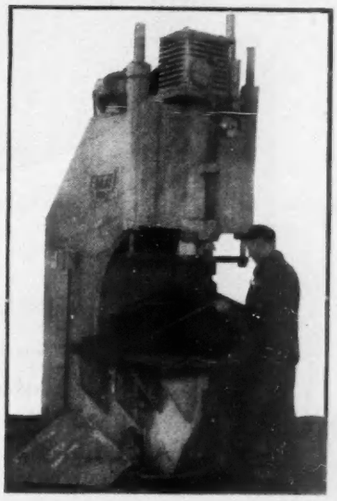


Vertical Press Model V120 & V150.

The same adaptability for a wide variety of shipping construction work is now available to ship constructors as has been to constructional engineers, railway engineers, mining engineers and general steel fabricators, for many years.



Ship 'tween deck columns in ½in. plate 15ft. long formed on FINLAY V150 Hydraulic Press.



Flanging ½in. thick plate gussets for hull construction on FINLAY V150 Hydraulic Press.

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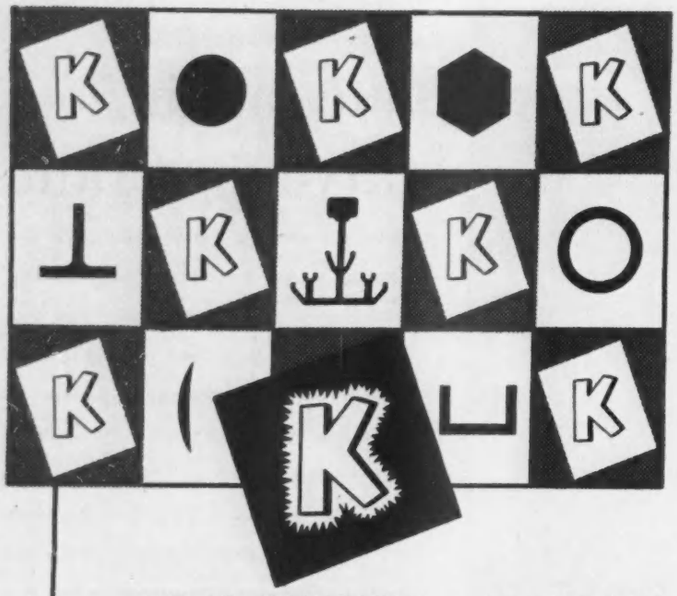

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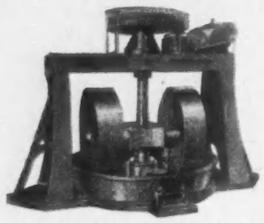

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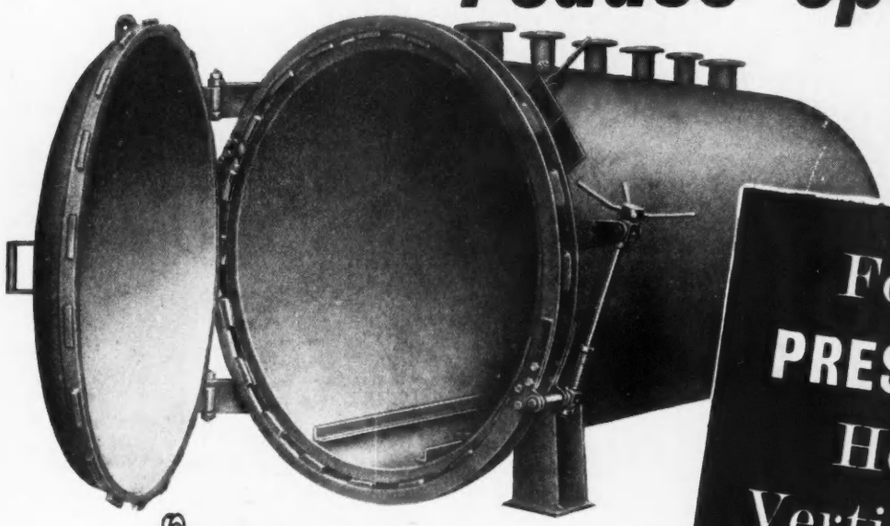

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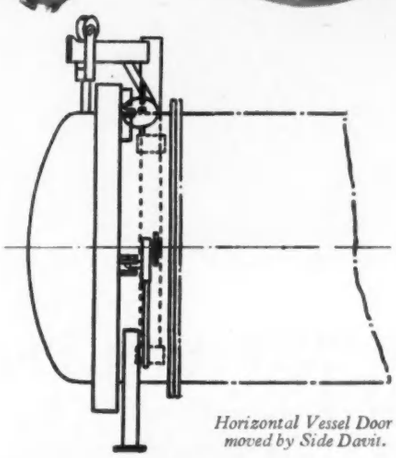
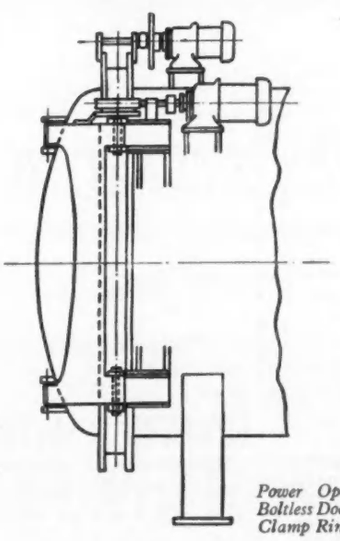


Horizontal Vessel Door moved by Side Davit.



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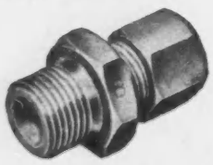

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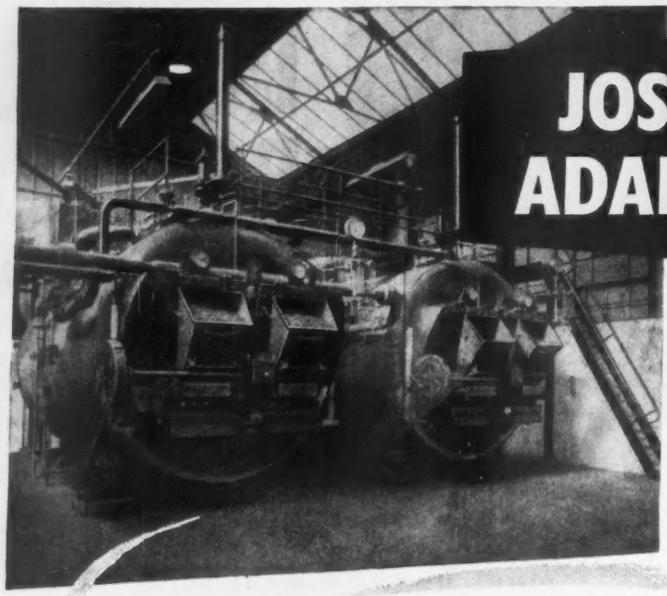

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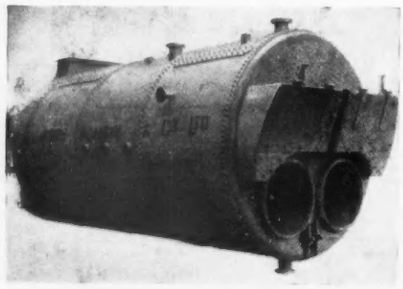

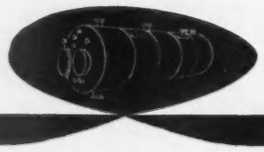

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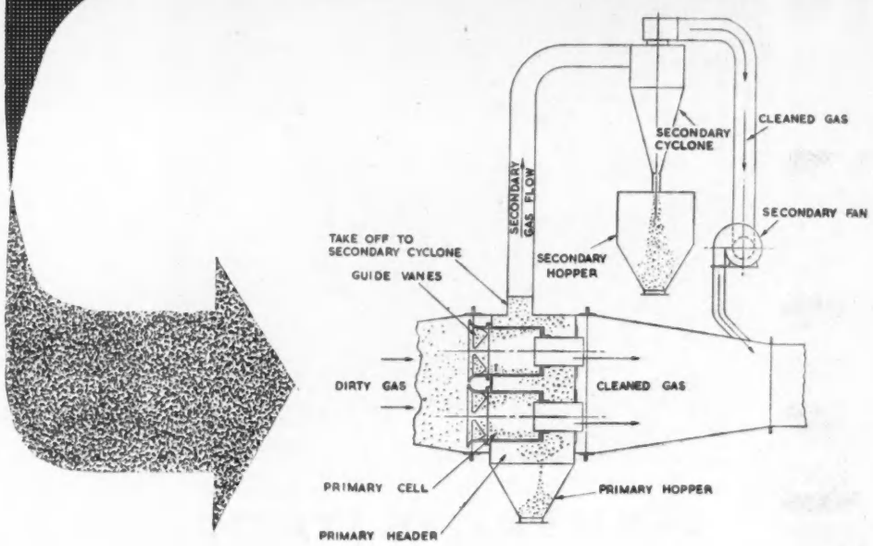

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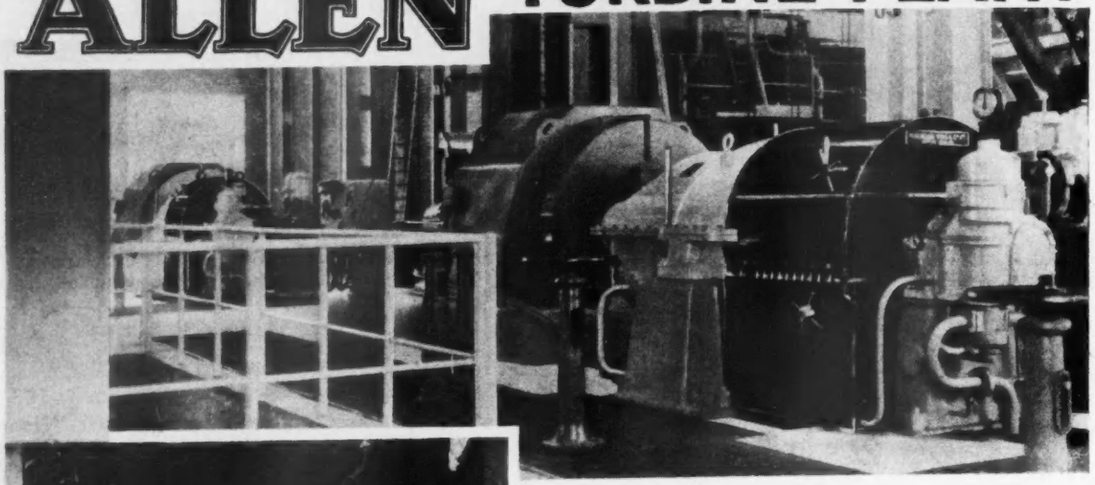

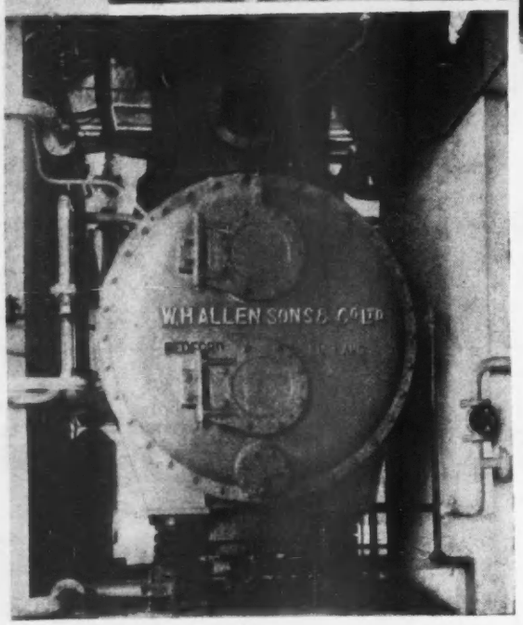

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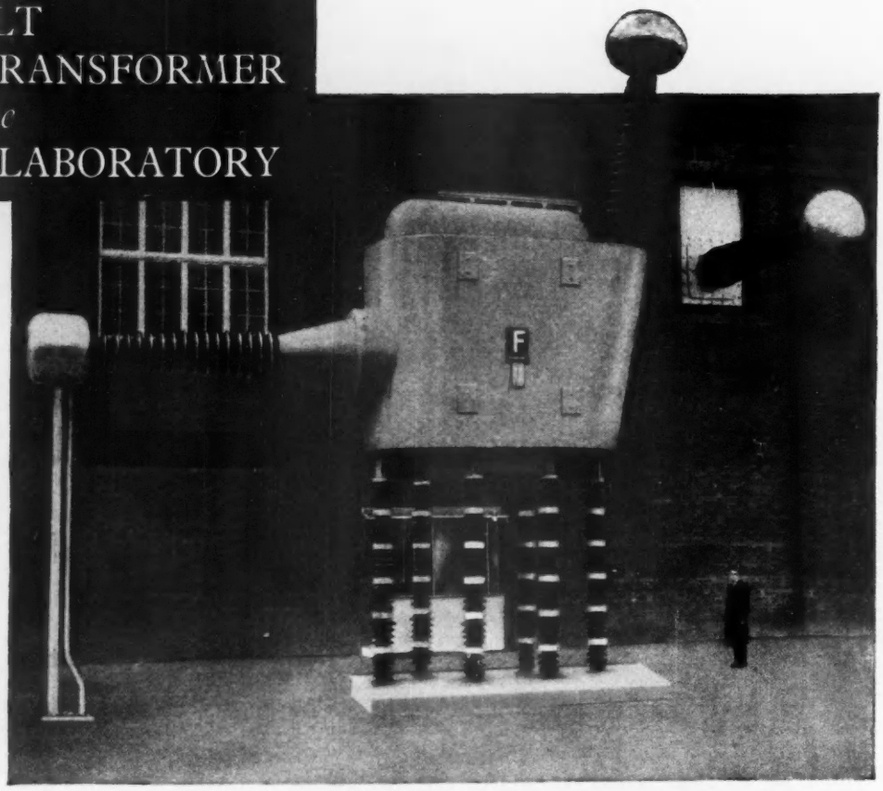

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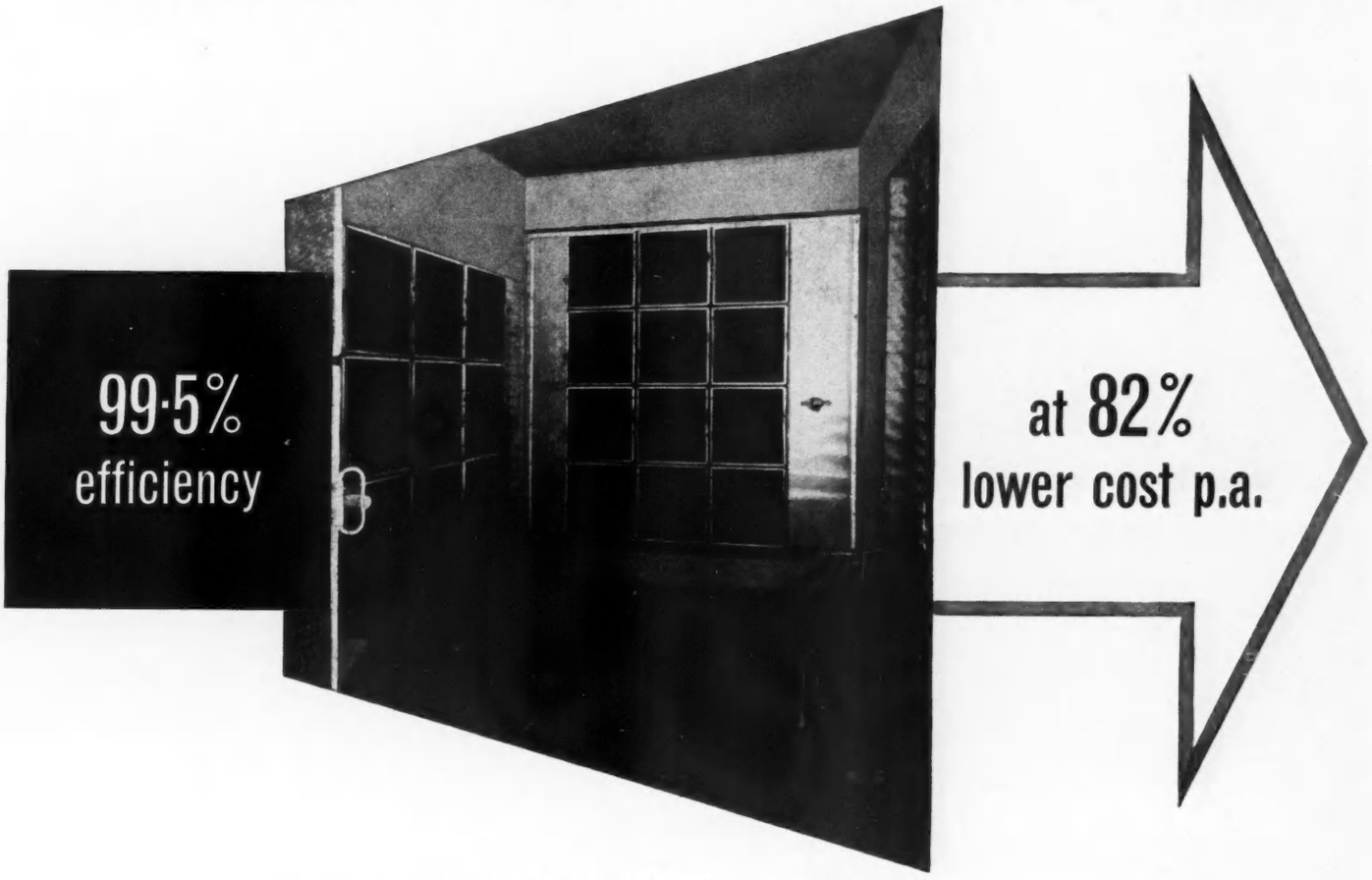

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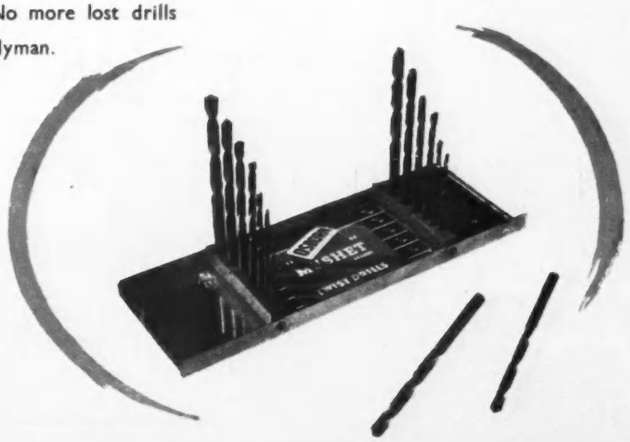

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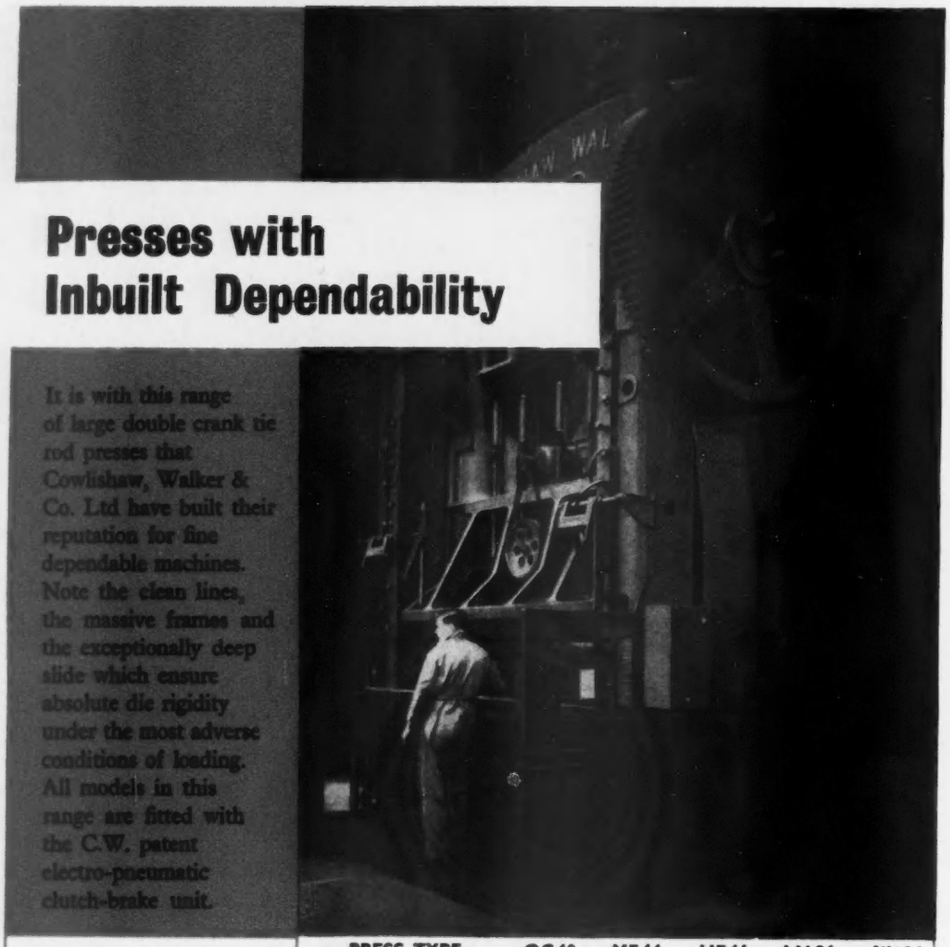

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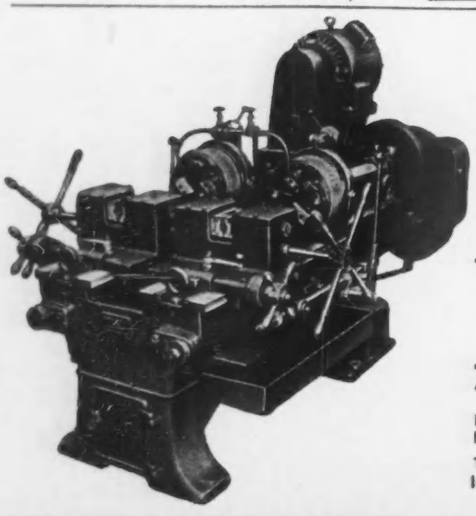

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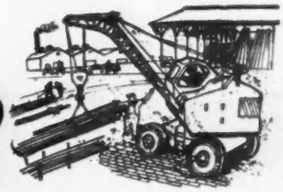

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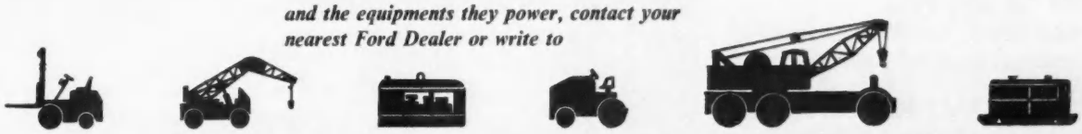

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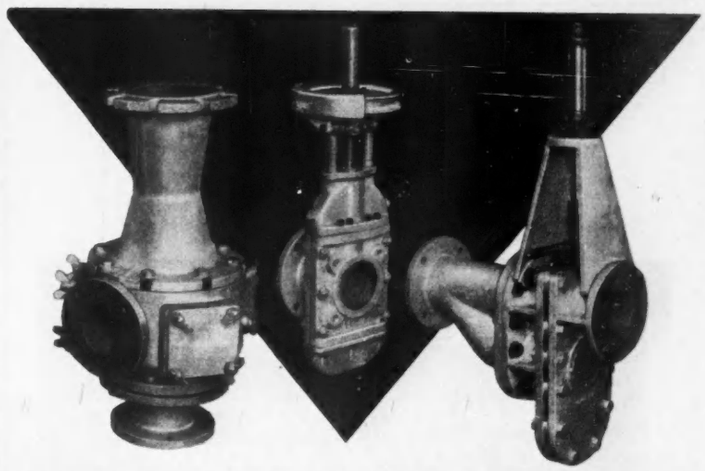

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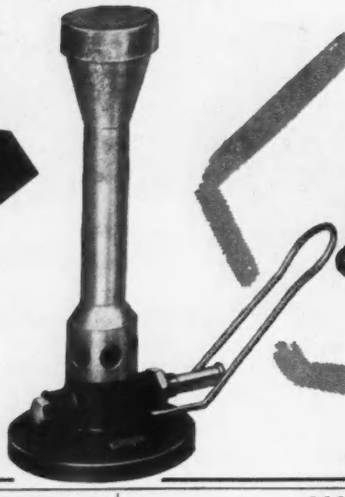

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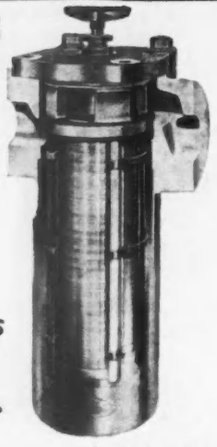

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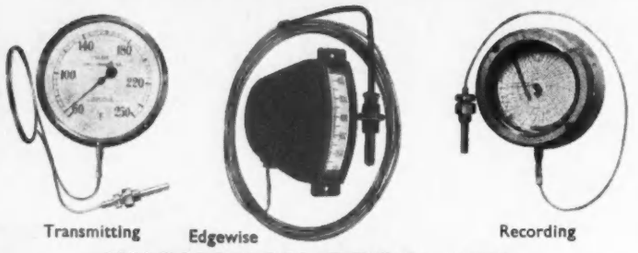

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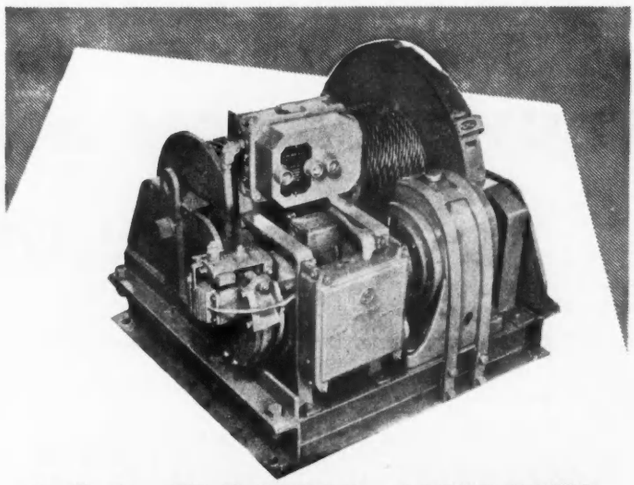

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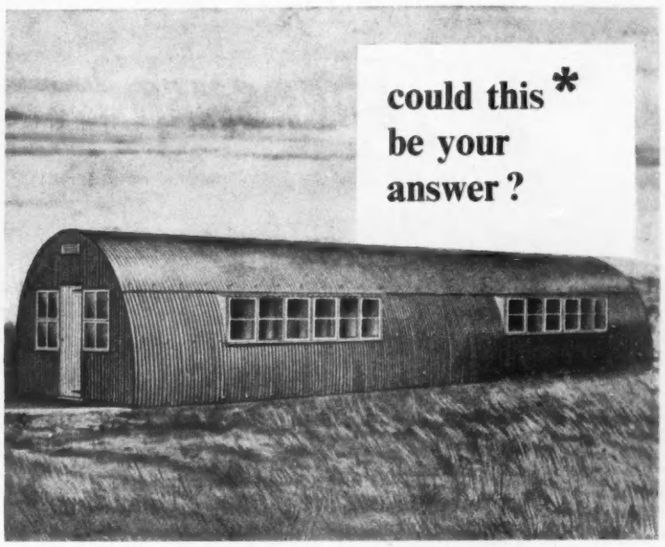

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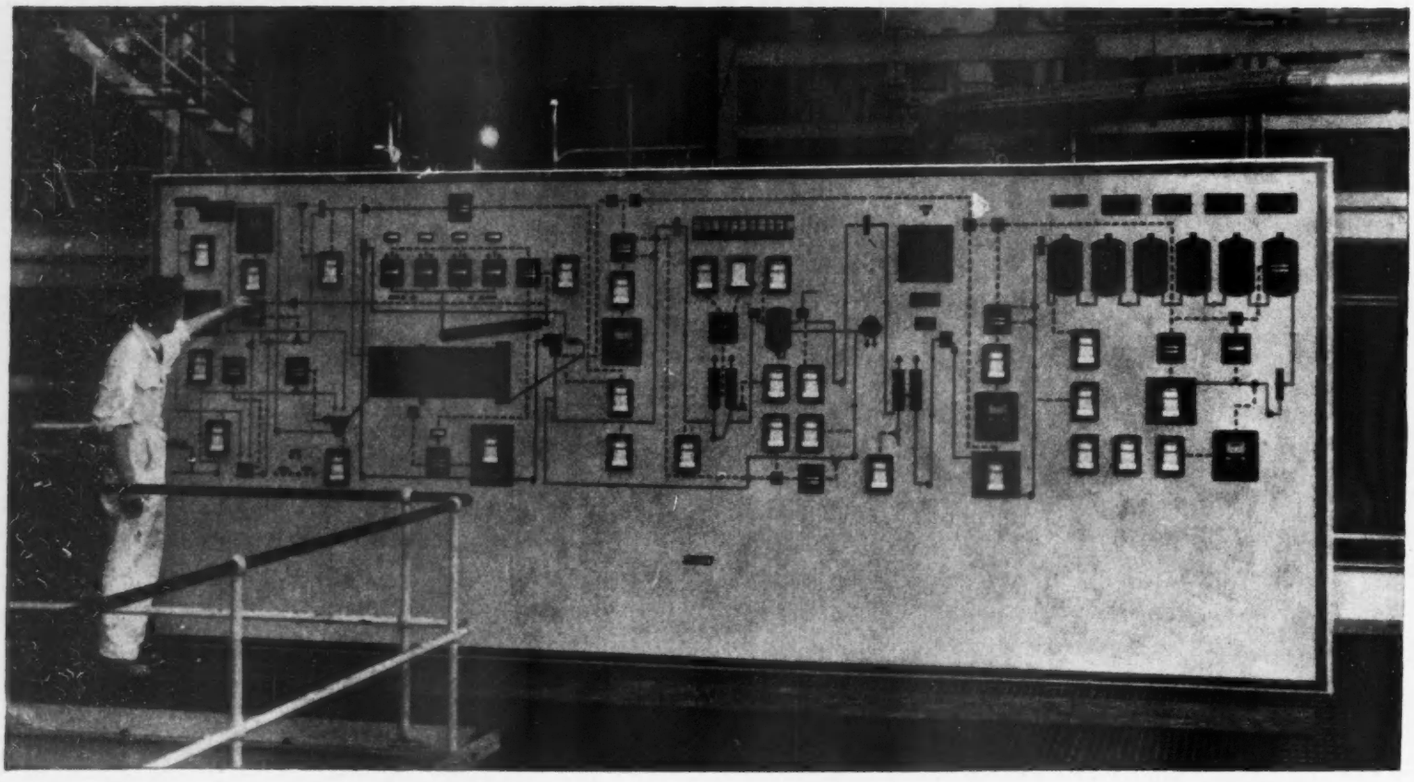

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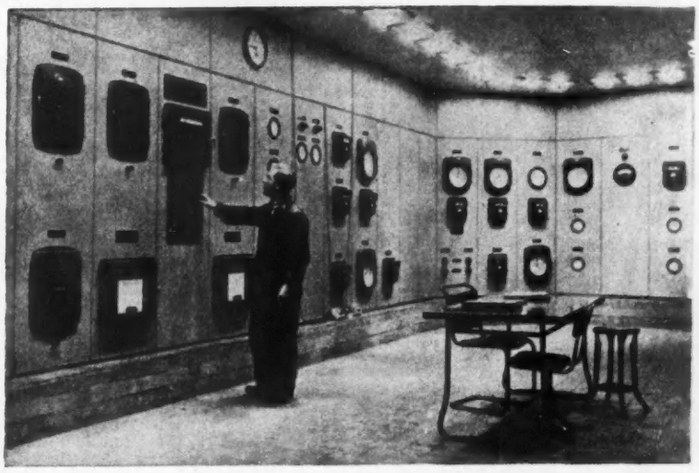

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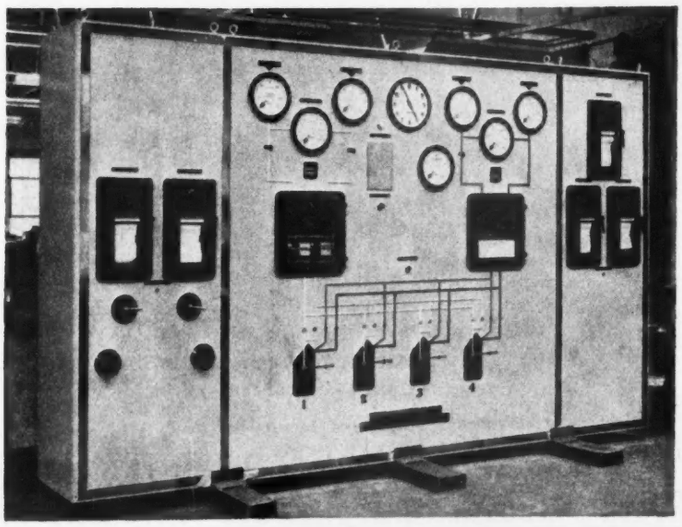

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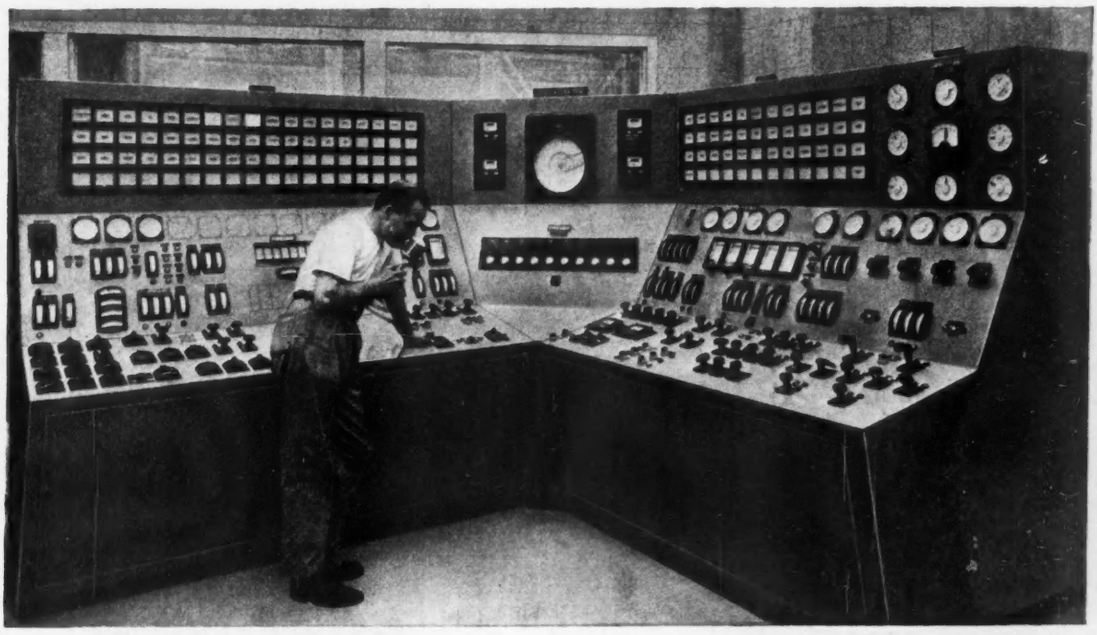

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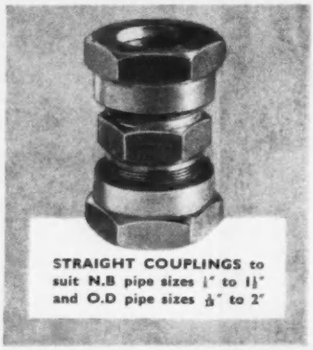

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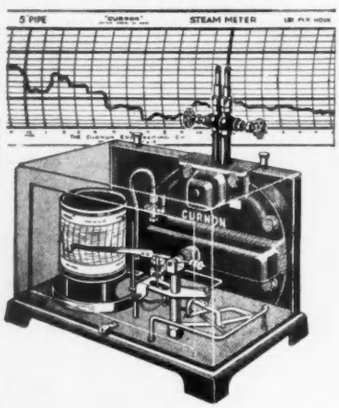

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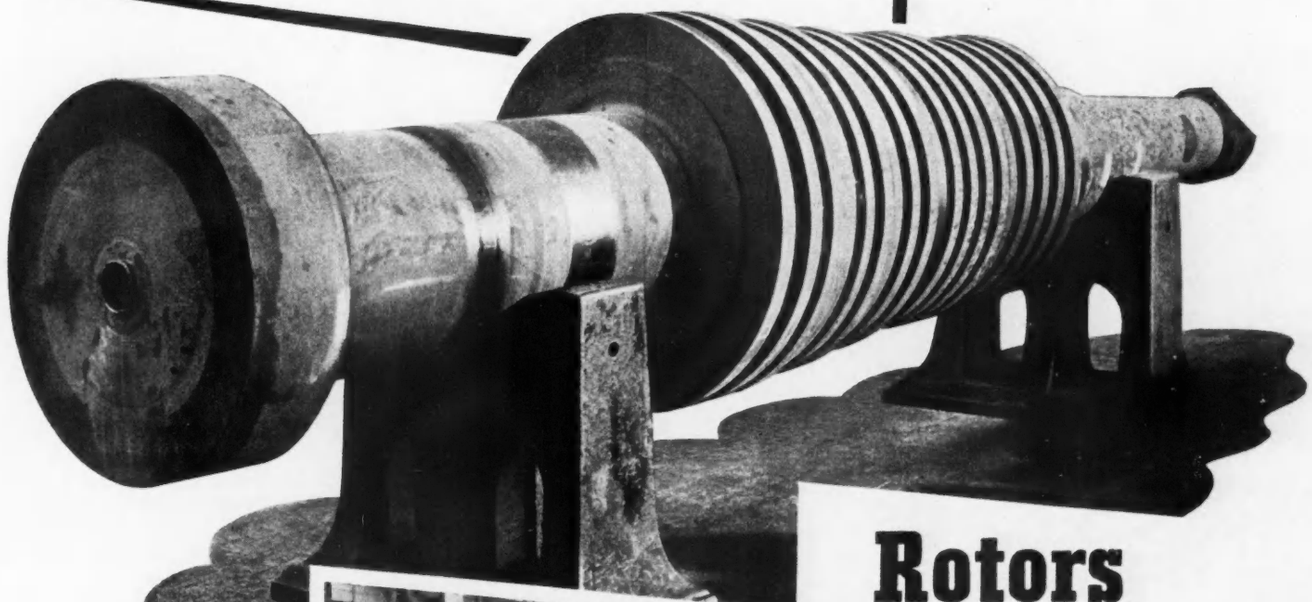

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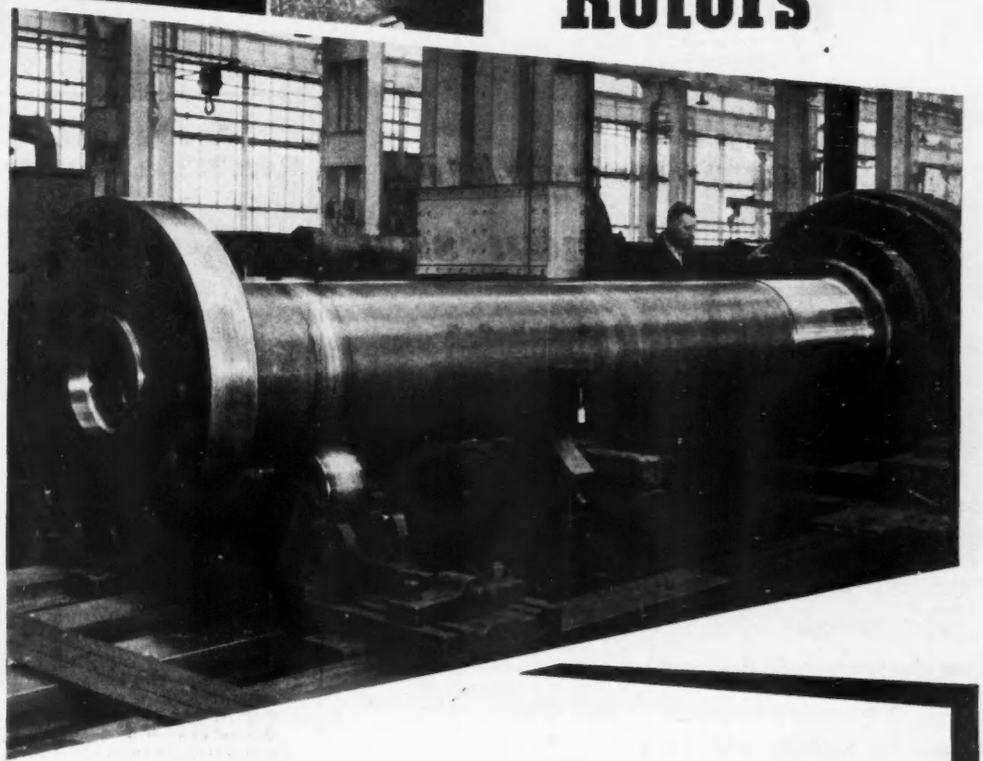

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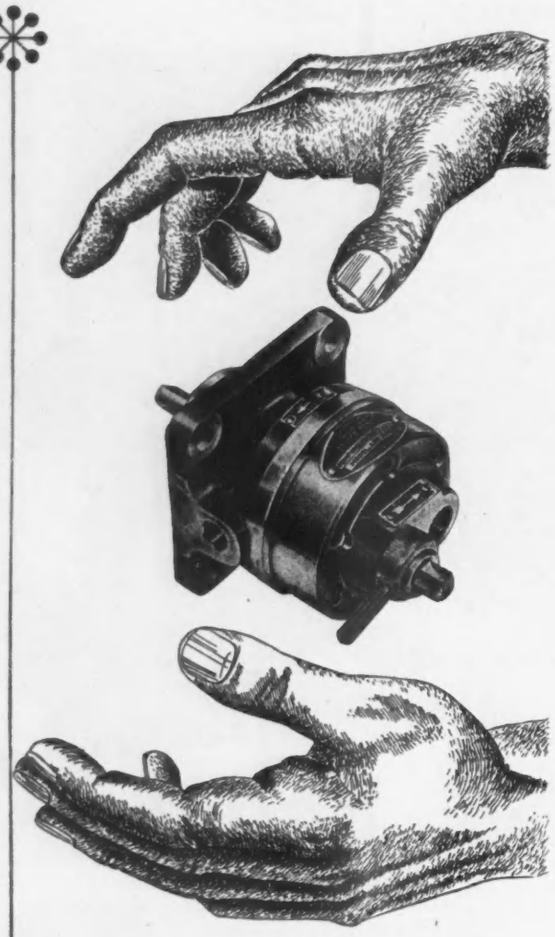

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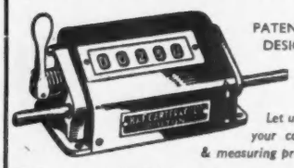

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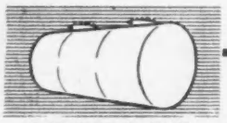

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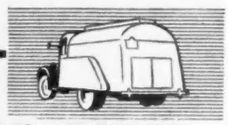

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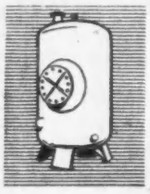

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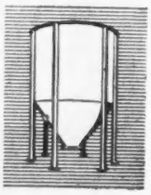

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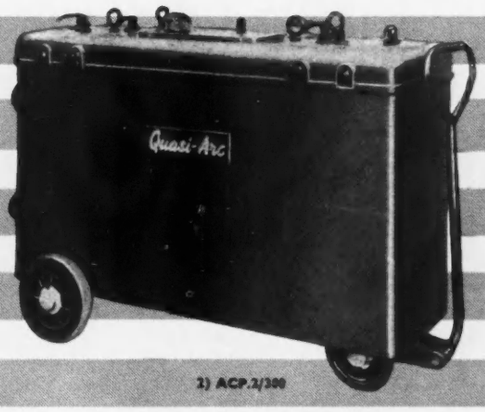

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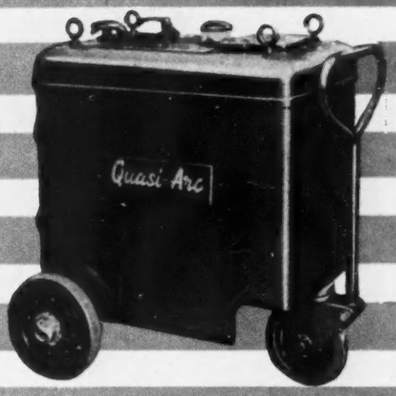

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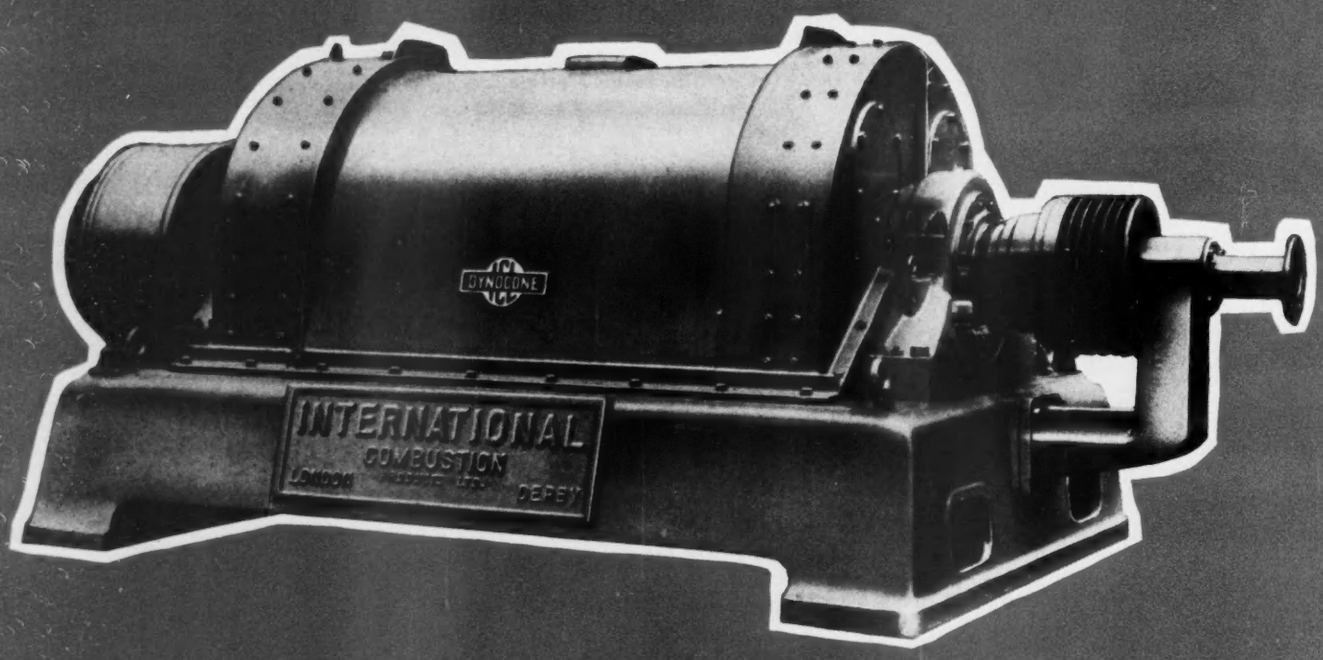

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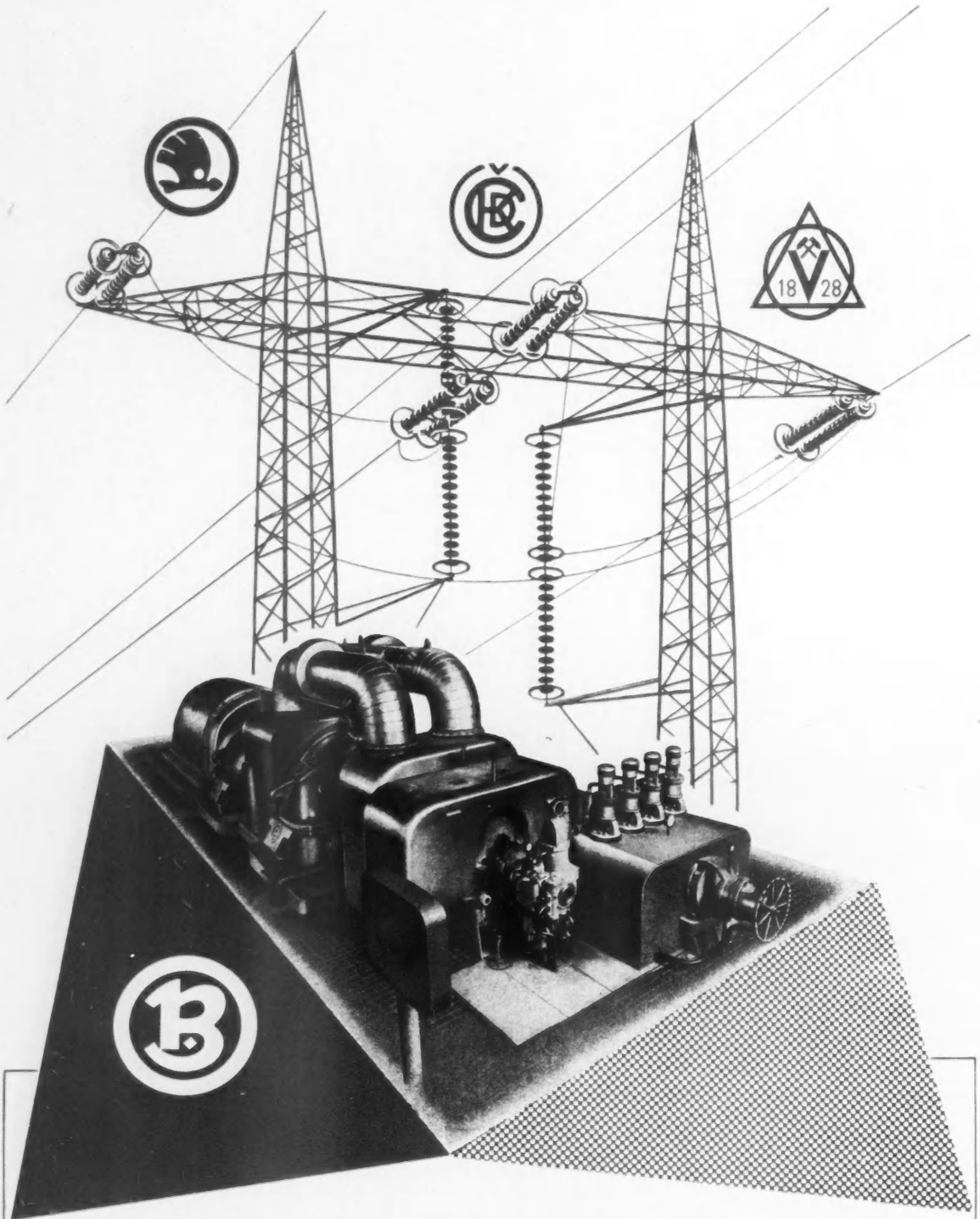

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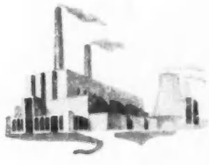

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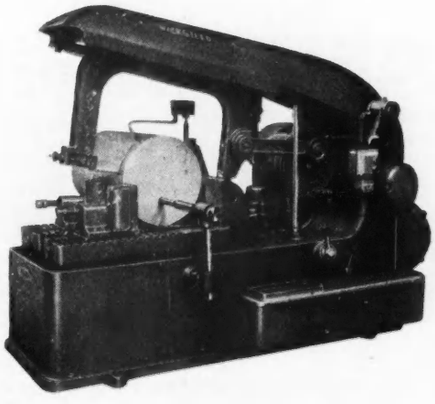

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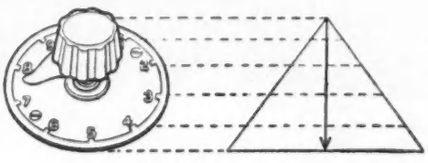

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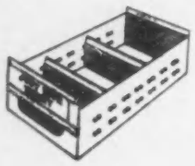

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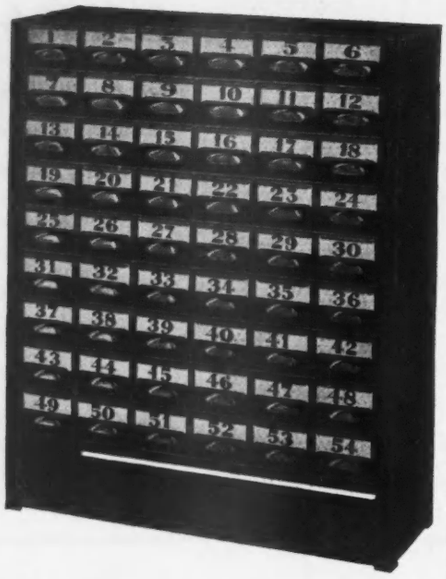

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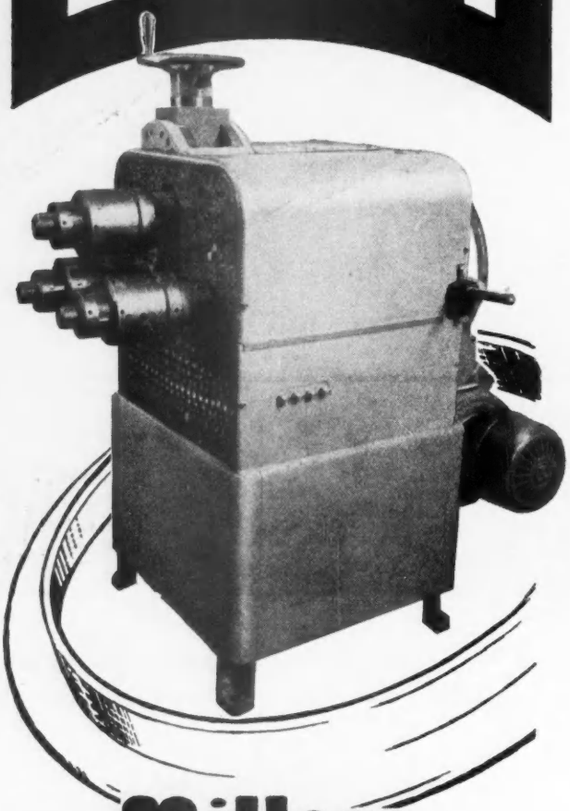

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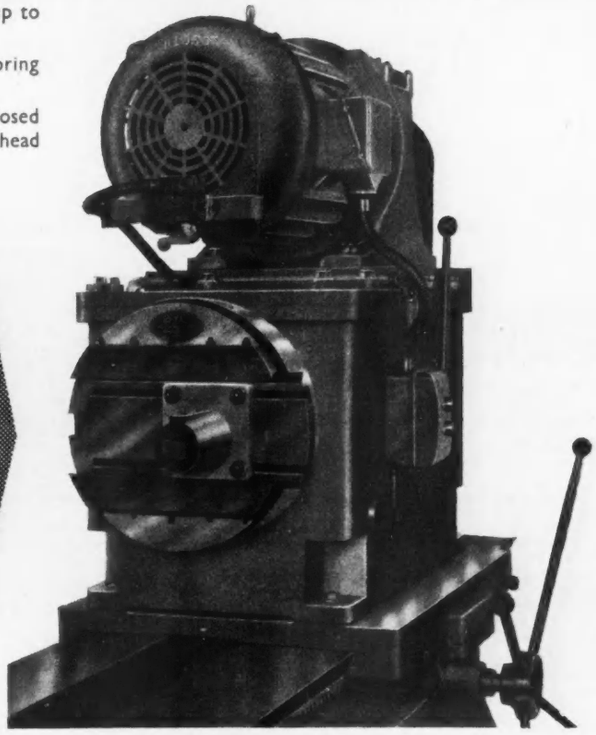

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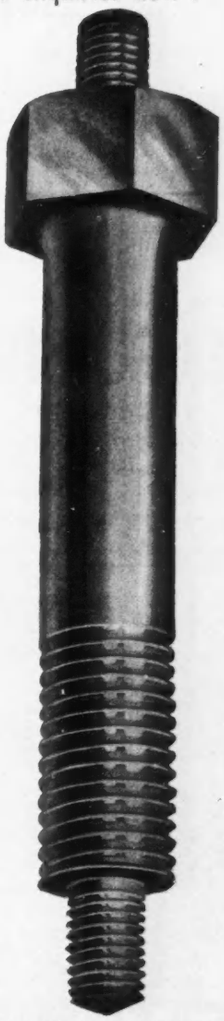

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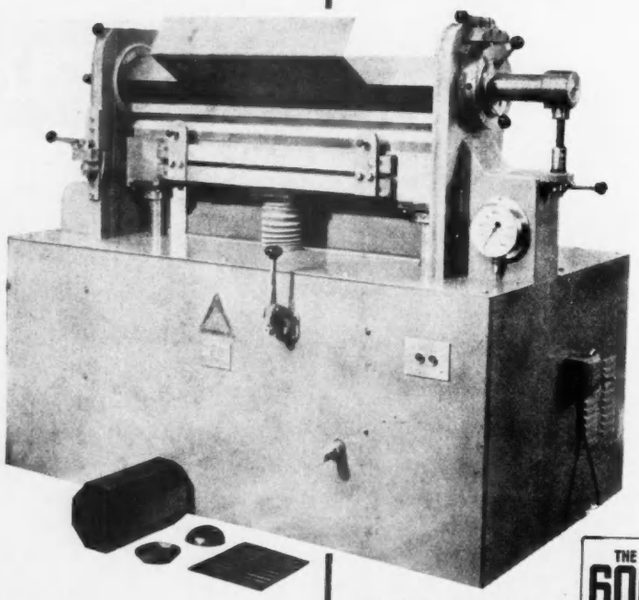

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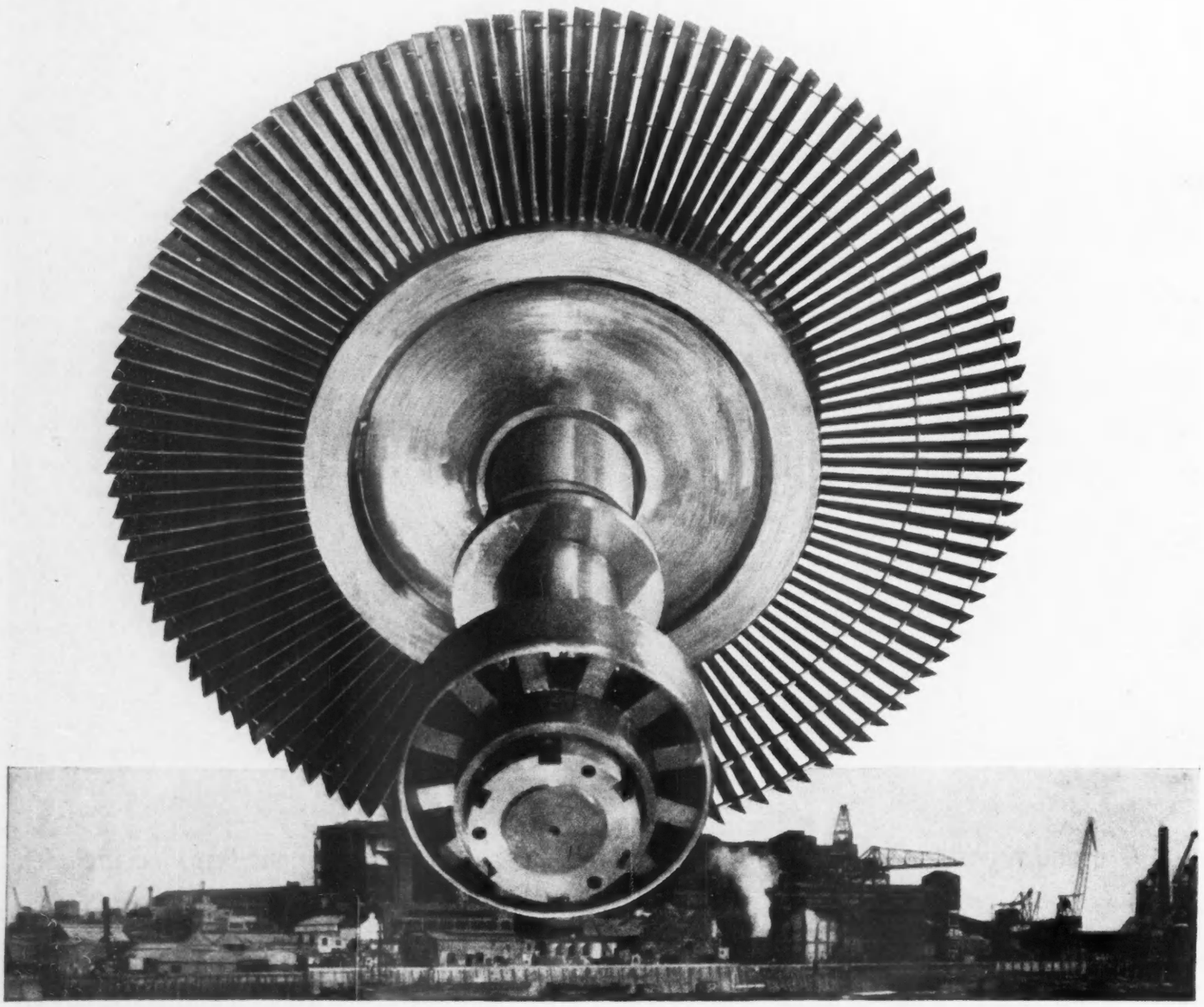

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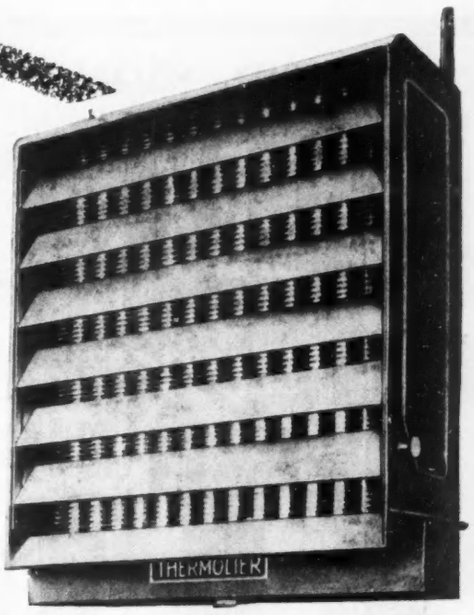

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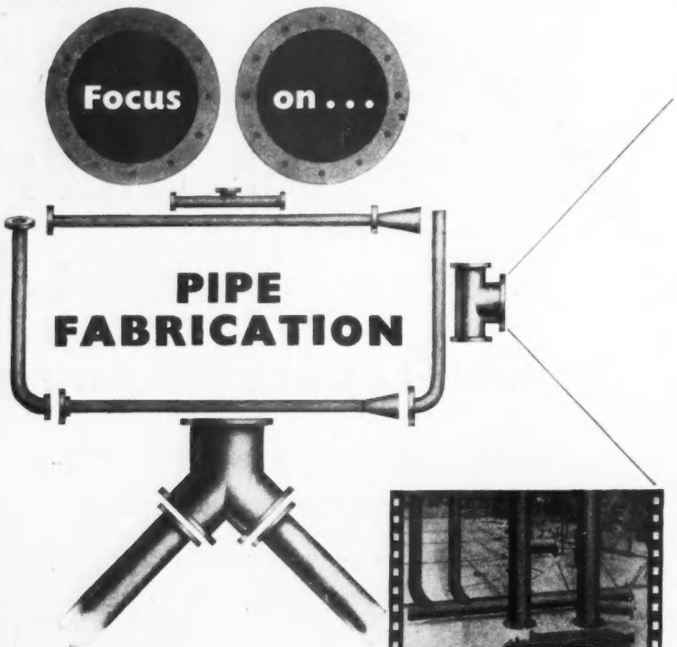

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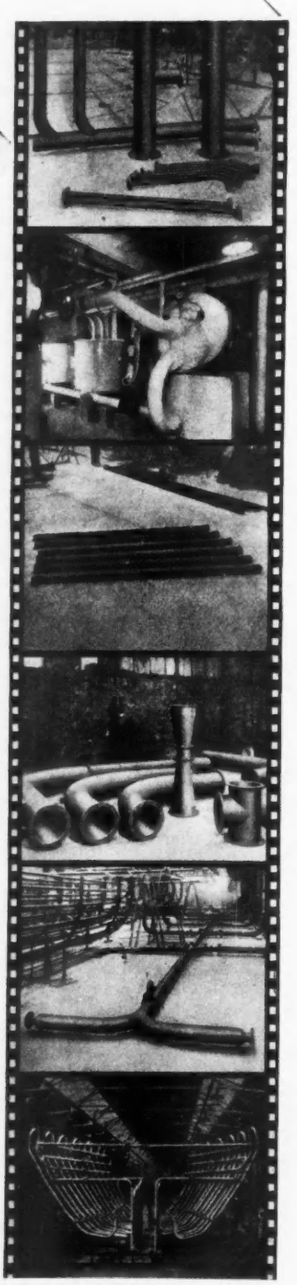

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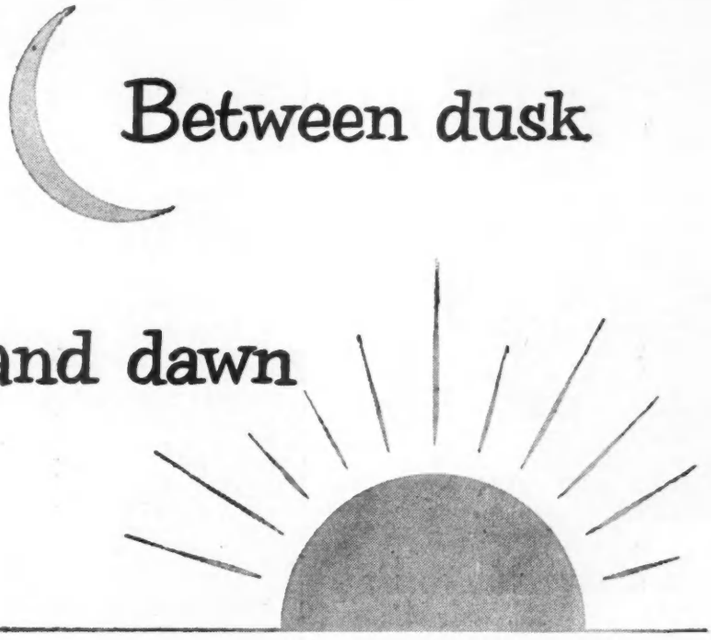
Between dusk



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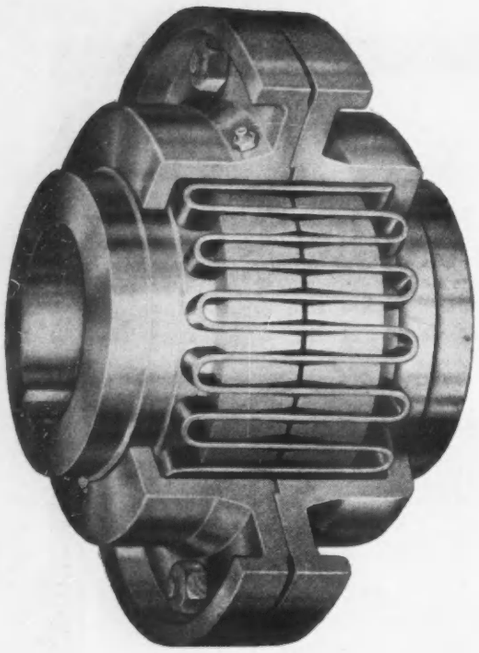

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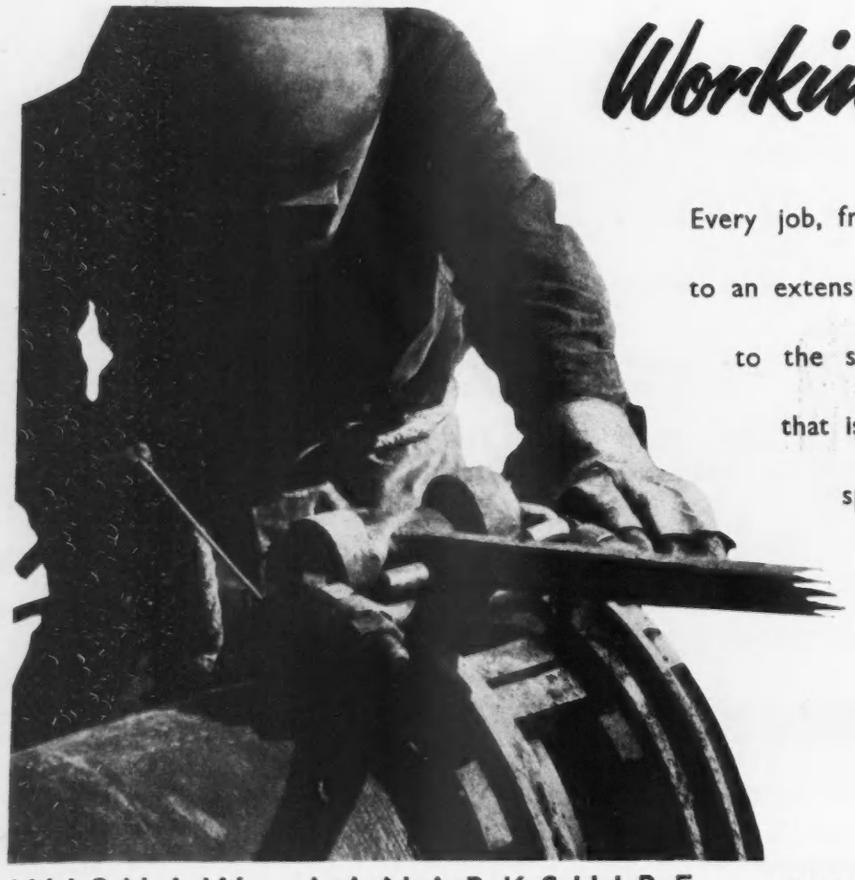

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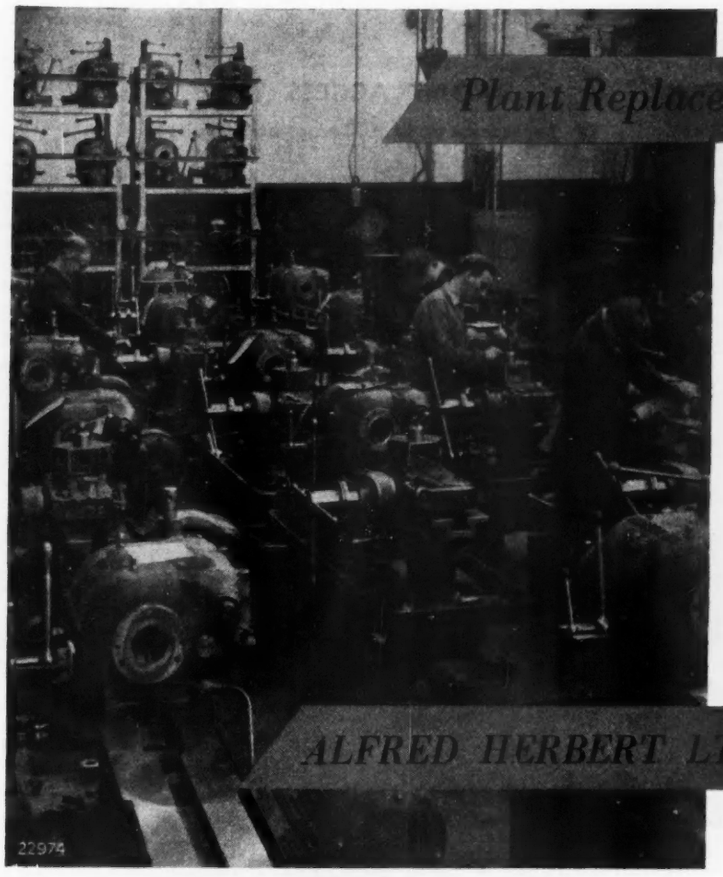

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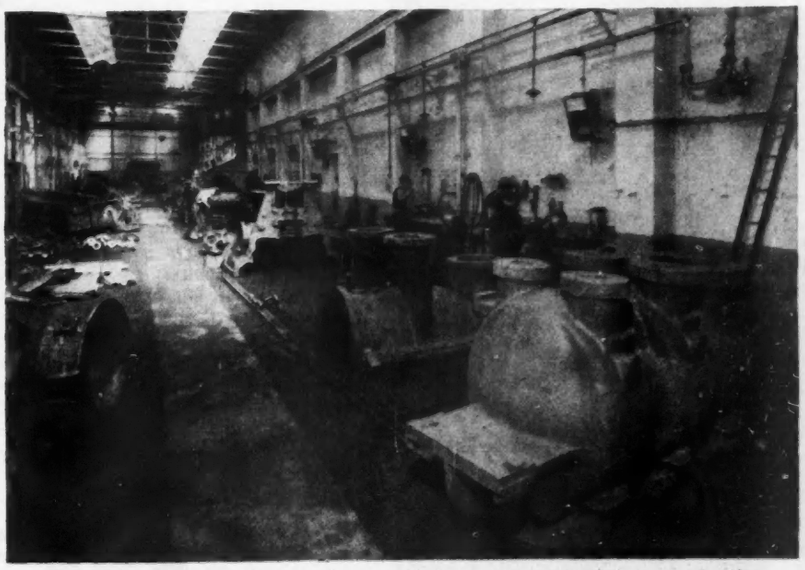

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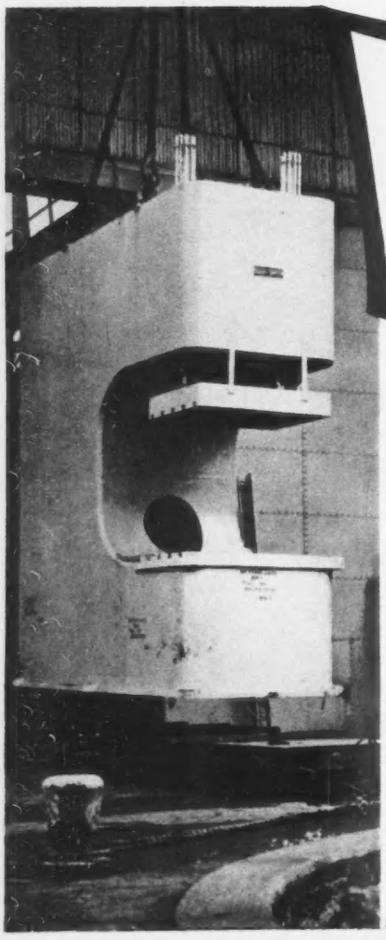

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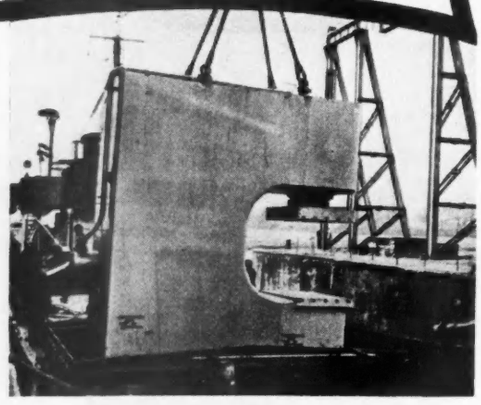

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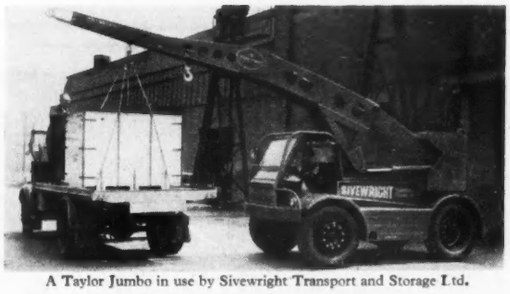
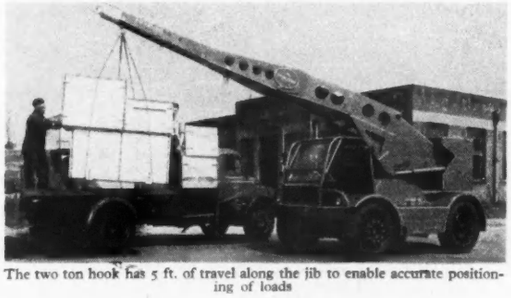


A Taylor Jumbo in use by Sivewright Transport and Storage Ltd.



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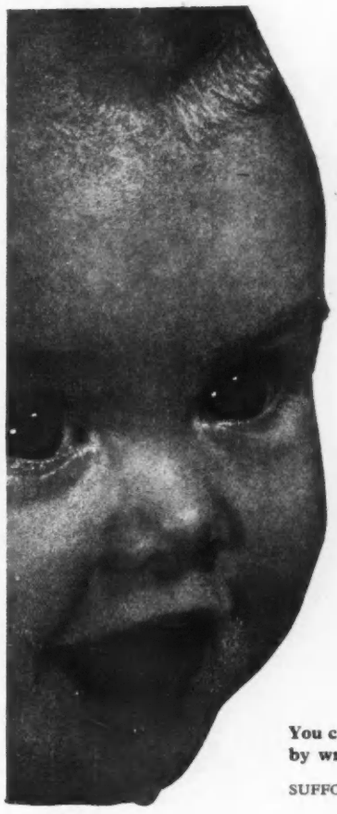

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Much time and material can be saved in using mechanical tubing, particularly when manufacturing rollers and ring shaped machine parts.

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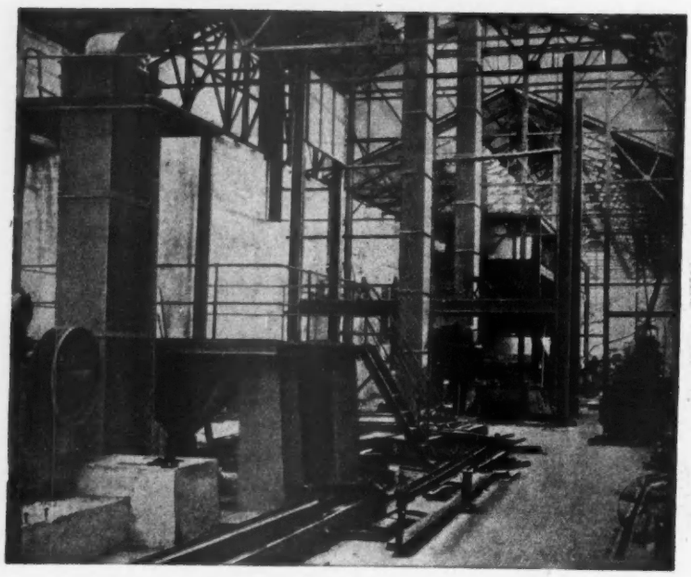

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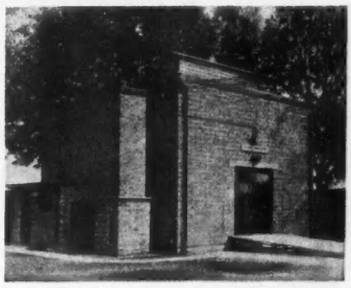

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874

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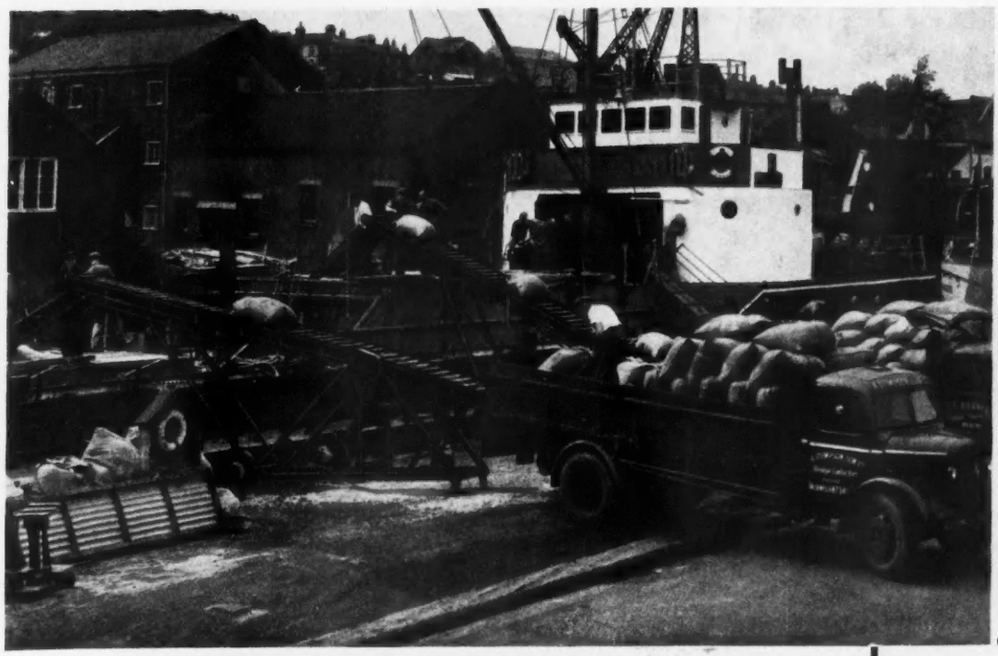

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T. & T. Conveyors and Elevators make your work easier and reduce your handling costs because T. & T. give you the benefit of their world-wide experience on many hundreds of large and small installations of every possible type. Write for leaflet E., or ask our technical representative to call.

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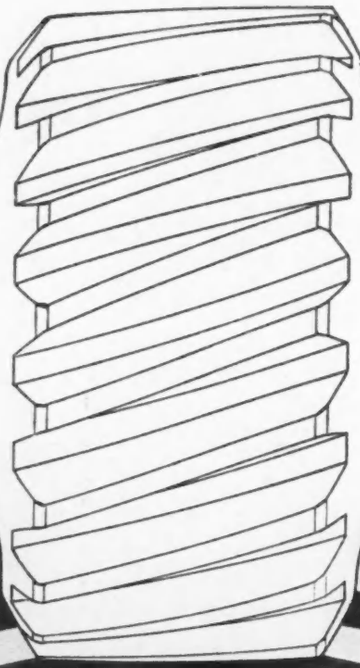
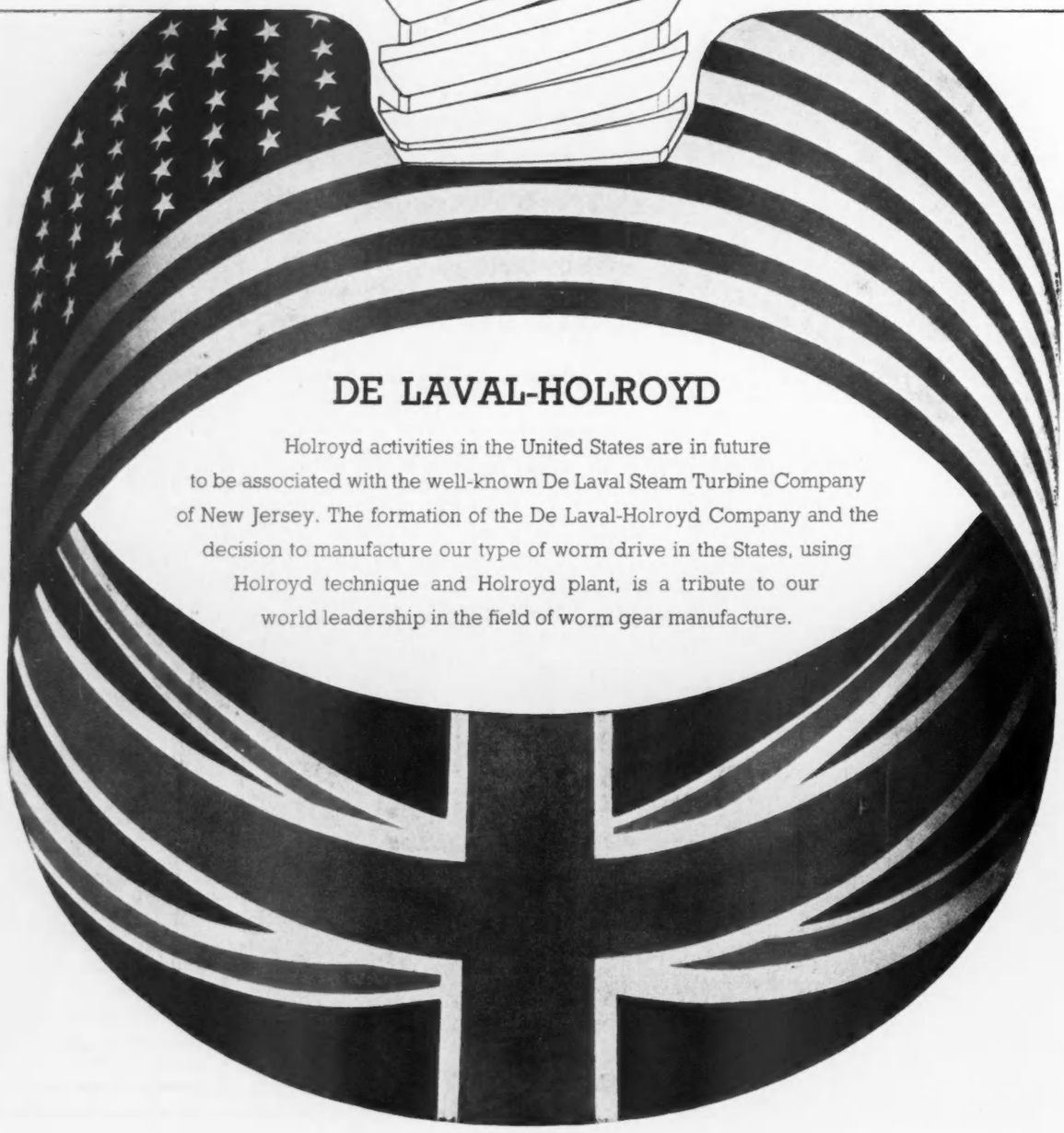
GEARED TOGETHER





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Holroyd activities in the United States are in future to be associated with the well-known De Laval Steam Turbine Company of New Jersey. The formation of the De Laval-Holroyd Company and the decision to manufacture our type of worm drive in the States, using Holroyd technique and Holroyd plant, is a tribute to our world leadership in the field of worm gear manufacture.

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CRC.187

Bet you we've seen that before

—that component, Sir, which must be made in rubber. Not just *rubber*, but a rubber that will stand up to the conditions *you* want to impose—bet you we've seen that specification before. We've been making rubber of all kinds, in so many shapes and sizes, for so long, for so many industries—that the chances are we already have what you are wanting. If not, we can soon make it.

'Doc' knows all the answers!

In case you didn't see our last advertisement, 'Doc' is the personification of John Bull technical and scientific knowledge. He is always happy to put his brain to work on *your* behalf.

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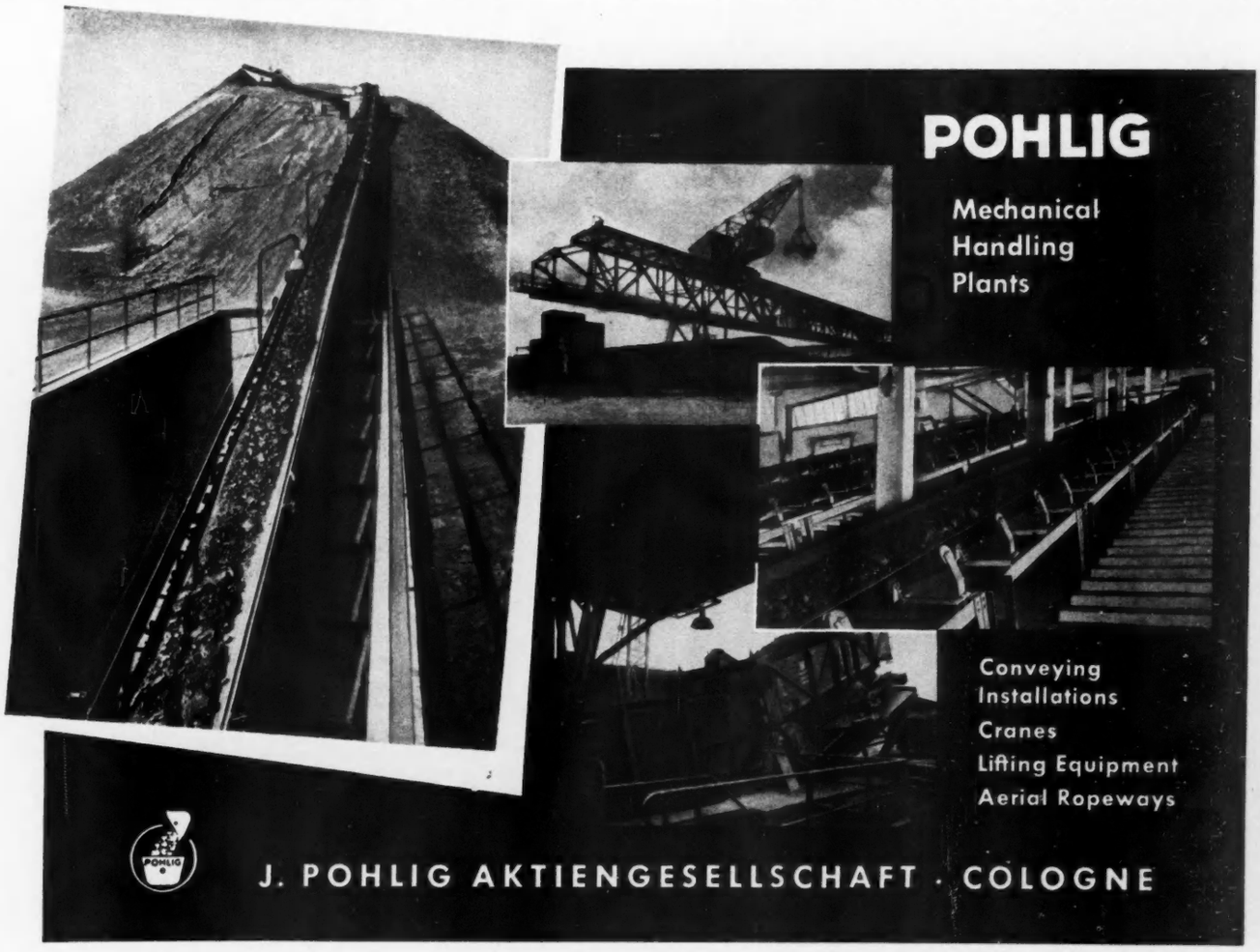

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There is a thickness of . .
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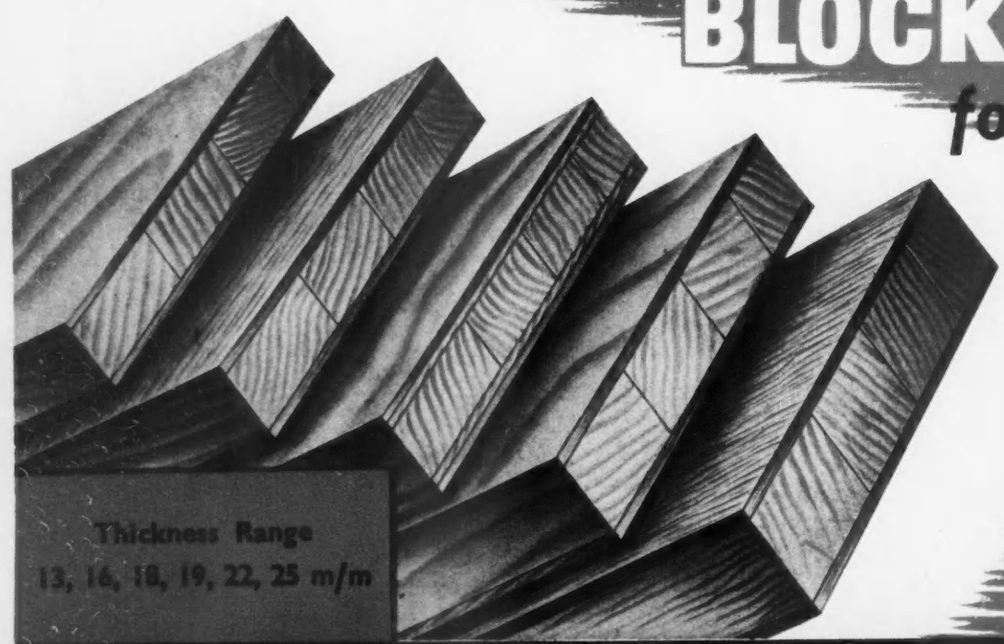

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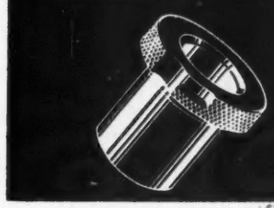
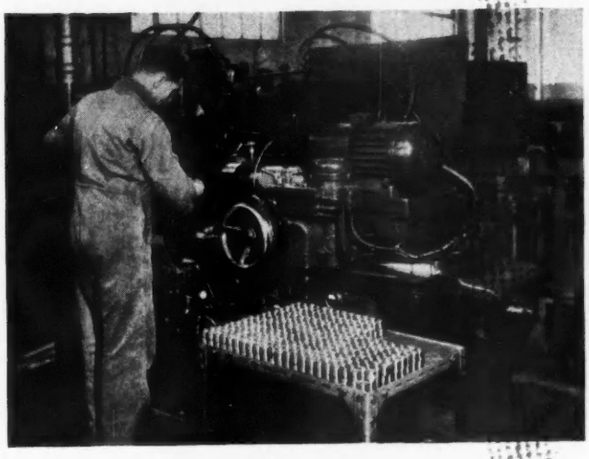


the best bushes — and the set-up that gives the best service



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Over 23,000 sizes available—and this figure does not include all the Continental and American standards in regular production. The B.A.C. range is unmatched for scope or availability, pointing to one clear conclusion—***the best bush maker gives the best bush service.***

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The Bush with 9 Lives

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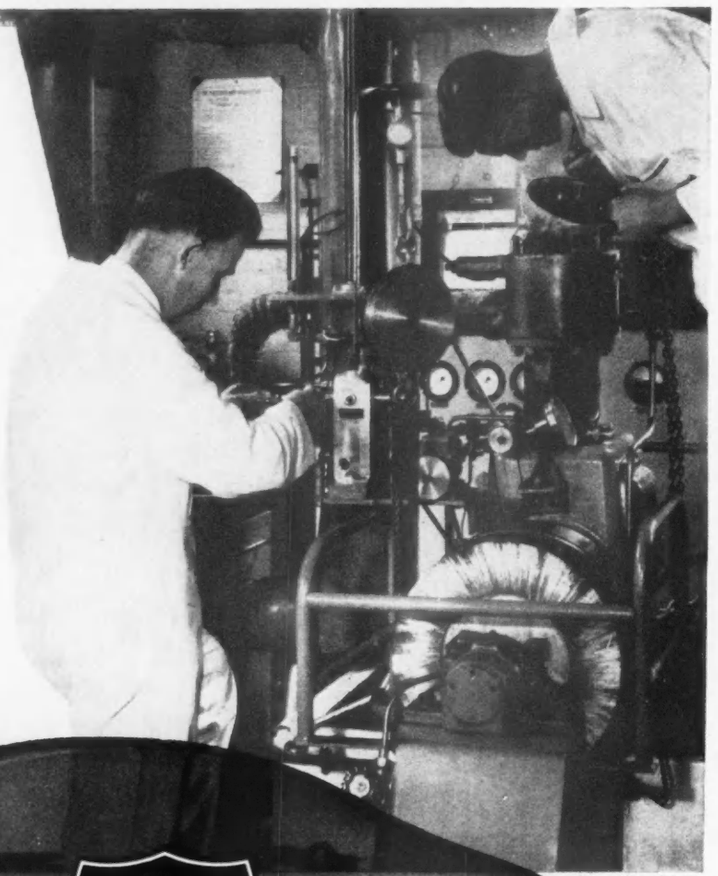

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Our Technical Department is at your service to advise on your lubrication requirements or problems

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THE JOINTING MATERIAL WITH THESE ADVANTAGES

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turbo charged engine

Six cylinders. 650 mm bore. 2,320 mm combined stroke. 115 r.p.m. 8,000 b.h.p. 8,700 i.h.p. 92% mechanical efficiency. 110 lb. sq. in. m.i.p.

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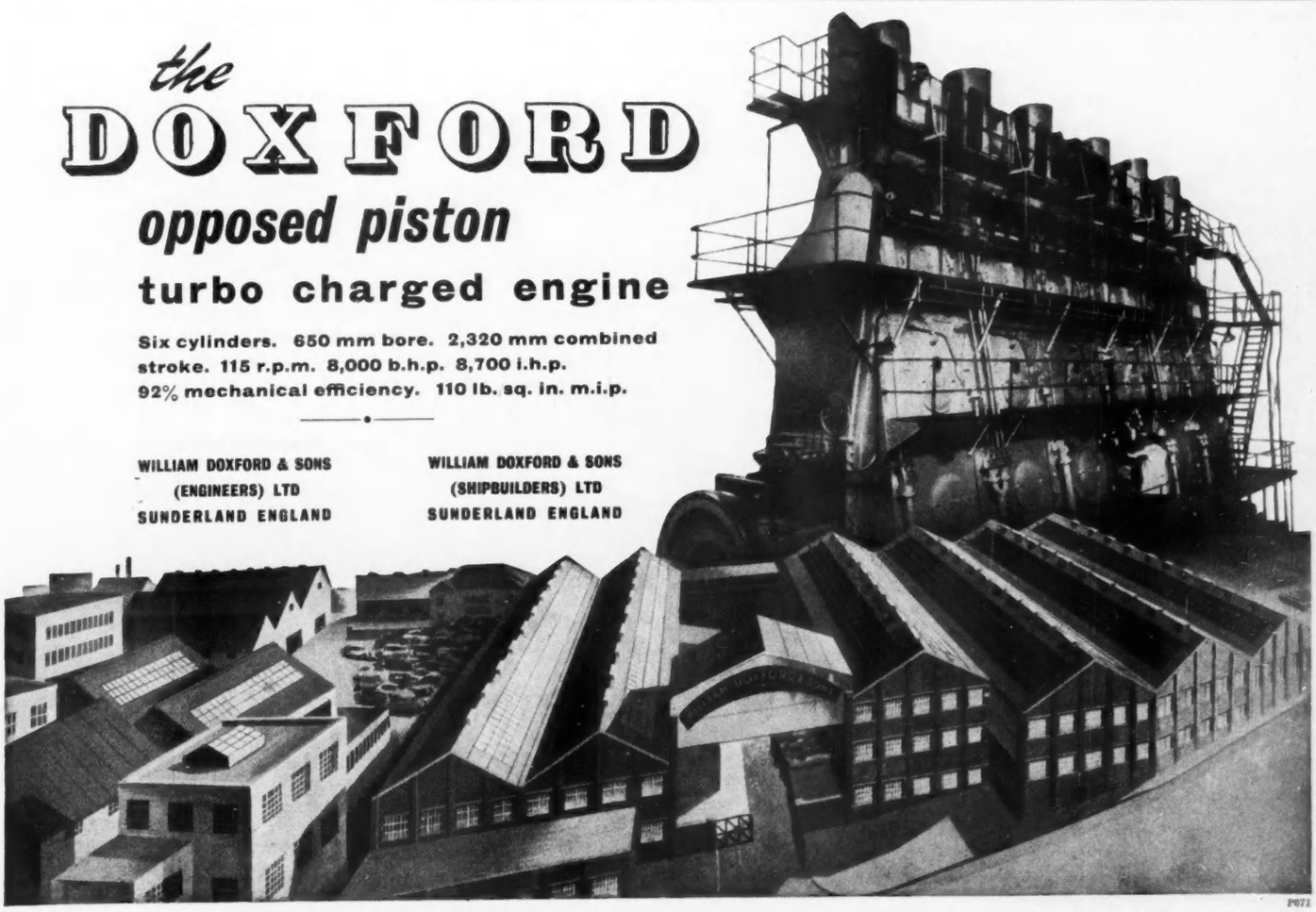

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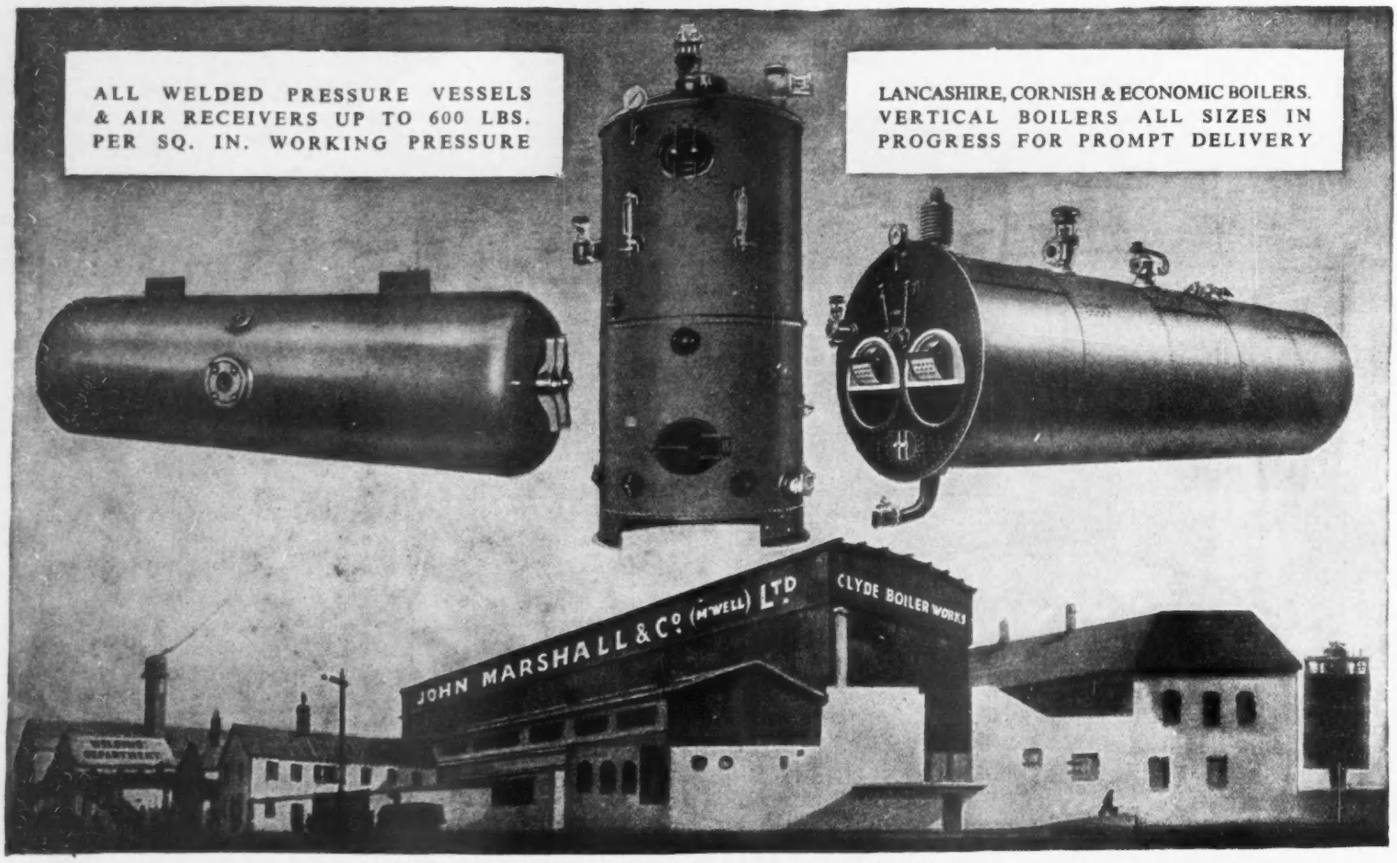
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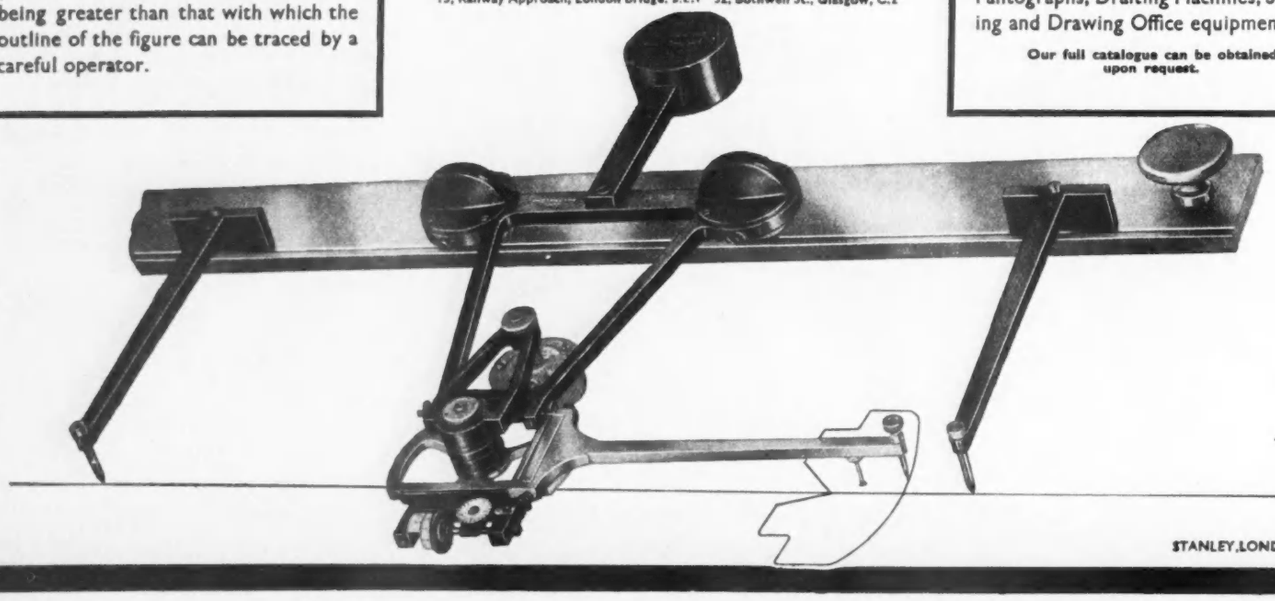
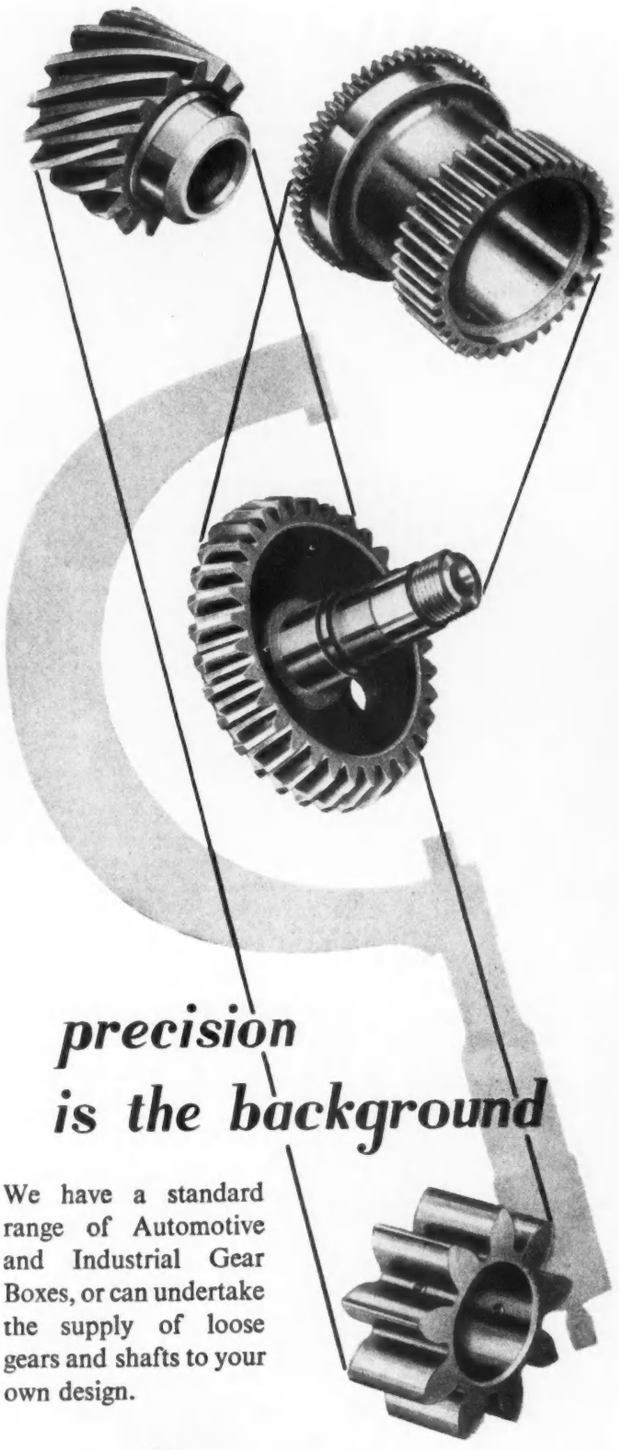


STANLEY, LONDON



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We have a standard range of Automotive and Industrial Gear Boxes, or can undertake the supply of loose gears and shafts to your own design.

Cut, ground or shaved Spur and Helical Gears. Ground Worms and Splines—Sprockets—Bevels—Reduction Units—Gear Boxes for all Trades.

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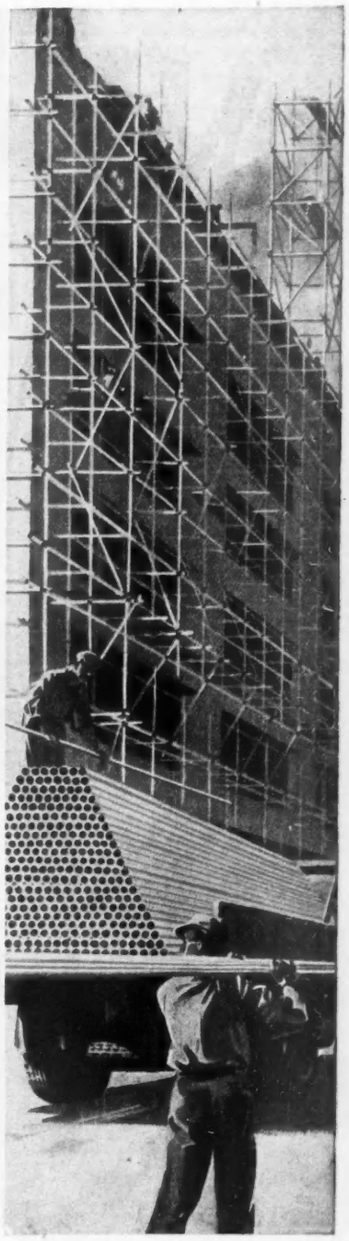

From the familiar . . . to the less familiar

Light, strong aluminium ladders are making life easier for painters, builders and workmen everywhere. Not only are they handier to carry and use, but a far sounder investment. Aluminium gives them a rugged durability that will stand up indefinitely to rough treatment and harsh weather. Excellent reasons, these, for using aluminium wherever such qualities count. Aluminium scaffold tubes, for example, can halve erection and dismantling times and cut transport costs by a third. Strong as conventional scaffolding and less than half as heavy, these aluminium tubes are easy to handle and are genuine time savers. No painting or other maintenance is necessary to keep them clean to work with and serviceable. Is aluminium speeding work for you?

Aluminium ingot, produced by Aluminum Company of Canada Ltd., is marketed by Aluminium Union Limited. In addition, the Company exports the products of the various fabricating companies of the Aluminium Limited Group.

Aluminium Union Limited

(Incorporated in Canada)

THE ADELPHI, JOHN ADAM STREET, LONDON, W.C.2

An ALUMINIUM LIMITED Company

OFFICES, ASSOCIATED COMPANIES AND AGENTS THROUGHOUT THE WORLD

MILLS grooved pins

NO REAMING

NO TAPPING

DRILL AND DRIVE HOME!

12 different types to suit all needs

EXORS. OF JAMES MILLS LTD.

BREDBURY STEEL WORKS
WOODLEY. NR. STOCKPORT
Telephone: WOODLEY 2231.(10 lines) Telegrams: "MILLS" PHONE WOODLEY

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Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

Advertisements for publication should be addressed to:— **Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

CITY OF CARDIFF EDUCATION COMMITTEE

LLANDAFF TECHNICAL COLLEGE

Principal: J. COTTERELL, M.I.E.E., A.I.Mech.E., A.M.I.Prod.E., A.M.Brit.I.R.E., M.A.M.E.M.E.

APPOINTMENTS

Due to the development of the work in the Engineering Department of the College, applications are invited for the following new full-time posts to commence on 1st September, 1958.

(1) GRADE B ASSISTANT IN MECHANICAL ENGINEERING—to teach up to and including Ordinary National Certificate level, Mechanical Engineering Subjects.

(2) GRADE B ASSISTANT IN PRODUCTION ENGINEERING—to teach, in the first instance, both the theoretical and practical subjects to Intermediate standard of the City and Guilds Machine Shop Engineering Courses.

Candidates for both the above Grade B appointments should possess one or more of the following qualifications:—A Degree or Associate Membership of a Senior Institution, or a Higher National Certificate, or Full Technological Certificate awarded by the City and Guilds for the appropriate work. Applicants should also have sound industrial and teaching experience.

(3) GRADE A ASSISTANT IN ELECTRICAL CRAFT WORK—to teach the theoretical and practical subjects of the City and Guilds Electrical Fitters', Installation, and Technicians' Courses.

(4) GRADE A ASSISTANT IN WELDING—to teach both theoretical and practical subjects in Electric Arc and Oxy-Acetylene Welding to City and Guilds standards.

(5) GRADE A ASSISTANT IN MECHANICAL ENGINEERING—to teach Engineering Drawing, Calculations and Science to Preliminary and Trade Courses up to the Intermediate City and Guilds level.

(6) GRADE A ASSISTANT IN MOTOR VEHICLE WORK—to teach theoretical and practical subjects in Motor Vehicle work at all levels from Preliminary to City and Guilds Motor Vehicle Service Mechanics' Certificate standard.

Candidates for the above Grade A appointments should possess at least a Higher National Certificate or Final City and Guilds Certificate in the appropriate work, or equivalent qualification. Sound industrial experience is essential and teaching experience would be an additional advantage.

QUALIFICATIONS

Candidates for these Grade A Assistant appointments should possess, as a minimum, an Ordinary National Certificate, a Final City and Guilds Certificate, or equivalent qualification in the appropriate work. Sound industrial experience is essential and teaching experience would be desirable.

SALARY

According to the Burnham Technical Scales:

Assistant Grade B, £650 by £25 to £1025.

Assistant Grade A, £475 by £25 to £900, plus, in the case of Assistants Grade A and B, additions for a Degree and approved training, with one increment for each each year of suitable industrial experience up to a maximum of 12 increments after the age of 21.

Application forms and further details may be obtained from the undersigned on receipt of a stamped, addressed envelope, and should be returned within fourteen days of the appearance of this advertisement.

R. E. PRESSWOOD,
Director of Education.

City Hall, Cardiff. E6262

HERTFORDSHIRE COUNTY COUNCIL

NORTH HERTS TECHNICAL COLLEGE

Principal: F. W. KELLAWAY, B.Sc., Dip.Ed.

SENIOR LECTURERS

The Governors invite applications for the following posts:—

(a) SENIOR LECTURER IN MATHEMATICS.
(b) SENIOR LECTURER IN ELECTRICAL ENGINEERING.
(c) SENIOR LECTURER IN THE DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING.

Salary range: £1350 to £1550.

Further particulars may be obtained by sending a stamped, addressed foolscap envelope to the Principal, North Herts Technical College, Broadway, Letchworth. E6246

PUBLIC APPOINTMENTS

BATTERSEA COLLEGE OF TECHNOLOGY
LONDON, S.W.11

A COLLEGE OF ADVANCED TECHNOLOGY

Principal: R. W. WEST, C.B.E., D.Sc., A.R.C.S., F.R.I.C., F.I.R.I.

APPOINTMENTS

Applications are invited for the following posts in the Civil and Mechanical Engineering Department:—

TWO READERSHIPS, a number of GRADE B ASSISTANT LECTURESHIPS.

The College offers good facilities for research, about 12 per cent. of the total work being post-graduate, and it is a condition of appointment that members of staff shall engage in research. In order that they may do this, the class contact hours have been reduced to 15 hours per week for Assistant Lecturers, and to correspondingly lower hours for the more senior grades of staff.

Candidates for the Readerships should state the particular field of engineering in which they have specialised. They should have research experience and be able to promote and supervise research and give post-graduate instruction within their particular field. Salary £1586 or £1598 by £50 to £1848.

Applicants for the Assistant Lectureships should be professionally qualified. Salary £761 or £773 by £25 to £1148, plus good Honours and training allowances and increments for experience.

Further particulars from the Clerk to the Governing Body, by whom applications should be received by 7th March, 1958. E6302

THE POLYTECHNIC

309, REGENT STREET, W.1

CIVIL AND MECHANICAL ENGINEERING DEPARTMENT

ASSISTANTS

Applications are invited for posts as FULL-TIME ASSISTANTS (Grade B) in Civil or Mechanical Engineering. The subjects to be covered include Soil Mechanics, Surveying, Heat Engines and Applied Mechanics.

The salary scale rises to a maximum of £1025 per annum, plus allowances for graduate status (£75), training (£25–£75), and London (£36–£48).

The commencing salary will depend upon qualifications and experience, and may include up to twelve increments in respect of approved service in industry. The posts are subject to superannuation and some concession in this respect may be made for previous industrial employment.

Further particulars, and a form of application, which should be returned by not later than 24th March, may be obtained from the undersigned.

J. E. RICHARDSON,
E6285 Director of Education.

COUNTY OF LEICESTER

COALVILLE MINING AND TECHNICAL COLLEGE

(Principal: W. A. BURROWS, B.Sc.)

HEAD OF DEPARTMENT OF ENGINEERING AND BUILDING, GRADE II

Applications are invited for the new post of HEAD OF DEPARTMENT OF ENGINEERING AND BUILDING, GRADE II (salary £1400 by £50 to £1600).

Applicants should be University Graduates in Engineering and/or have equivalent professional qualifications with appropriate teachingand industrial experience. Further particulars may be obtained from the Principal on receipt of a stamped, addressed envelope.

Applications (no forms), giving age, education, qualifications and teaching and administrative experience, together with copies of two recent testimonials and the names of three referees, should be sent to the Principal, Mining and Technical College, Bridge Road, Coalville, by 21st March 1958. E6293

PUBLIC APPOINTMENTS

CITY OF BIRMINGHAM EDUCATION COMMITTEE

POSTS IN TECHNICAL COLLEGES

Applications are invited for the following posts in Technical Colleges, to commence duty on 1st September next. Application forms (separate for each post) and further details, may be obtained from the Principal at the College concerned (stamped, addressed envelope), and should be returned to him within 14 days of the appearance of this advertisement. Salary scales in accordance with the Burnham (Further Education) Report, 1956:

Lecturer: £1200 by £30 to £1350.

Candidates may be granted additional increments above the minimum and up to the maximum of the above scale in accordance with their industrial, professional or research experience as approved by the Authority as of equivalent standard.

Assistant Grade B: man, £650 by £25 to £1025; woman, £580 by £20 to £820, plus equal pay increments.

Assistant Grade A: man, £475 by £25 to £900; woman, £430 to £720, plus equal pay increments.

Candidates may be granted additional increments above the minimum of the above scales for time spent in industry, commerce, professional work or research. There are also additions to the scale for a Degree or equivalent professional qualifications.

ASTON TECHNICAL COLLEGE,
WHITEHEAD ROAD, BIRMINGHAM, 6
Principal: D. D. Stockley, B.Sc., M.I.Mech.E.
Department of Mechanical Engineering:

LECTURER for O.N.C. and H.N.C. subjects (including Heat Engines). Engineering Degree or equivalent desirable.

ASSISTANT, GRADE B, for O.N.C. subjects (including Workshop Technology), and for general subjects associated with C. and G.L.I. courses in Machine Shop Engineering.

ASSISTANT, GRADE B, for O.N.C. subjects and for subjects associated with C. and G.L.I. courses in Motor Vehicle Mechanics' work. Practical experience in the motor industry desirable.

HANDSWORTH TECHNICAL COLLEGE, GOLDS HILL ROAD, BIRMINGHAM, 21
Principal: H. Marshall, B.Sc., A.M.I.Mech.E., A.M.I.P.E.

ASSISTANT, GRADE B, in the Department of Mechanical and Production Engineering, with experience in teaching Craft Practice and Theory.

BROOKLYN TECHNICAL COLLEGE,
ALDRIDGE ROAD, BIRMINGHAM, 22a
Principal: G. H. Palmer, M.Sc., A.Inst.P.
Department of Building and Engineering:

ASSISTANT, GRADE B, to teach Mechanical Engineering subjects to O.N.C. standard. Candidates should be adequately qualified in Mechanical Engineering, with a particular interest in Heat Engines. Industrial experience essential, teaching experience desirable.

GARRETTS GREEN TECHNICAL COLLEGE, GARRETTS GREEN LANE, BIRMINGHAM, 33
Principal: B. C. Whitehouse, B.Sc., A.R.I.C.
Department of Mechanical Engineering:

LECTURER in Mechanical Engineering, to teach subjects of the National Certificate Course in Mechanical Engineering up to the Ordinary level, together with responsibilities for the development of the Applied Mechanics Laboratory.

LECTURER in Mechanical Engineering, to specialise in the teaching and organising of Mathematics for the Ordinary National Certificate in both Mechanical and Electrical Engineering.

Applicants should possess a Degree (preferably in Mechanical Engineering) and/or Associate Membership of a recognised professional Institution, and have had both industrial and teaching experience. Experience in administrative work will be an advantage.

ERDINGTON TECHNICAL COLLEGE,
EDWARDS ROAD, BIRMINGHAM, 24
Principal: G. Greasley, D.I.C., M.I.E.E., A.M.I.Mech.E.

THREE ASSISTANTS, GRADE A: one post is with special reference to Pre-Senior teaching; the other two with reference to the teaching of workshop technology and engineering drawing.

E. L. RUSSELL,
E6296 Chief Education Officer.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

INSTRUCTOR IN ENGINEERING DRAWING AND DESIGN

INSTRUCTOR IN ENGINEERING DRAWING AND DESIGN required. Salary not less than £850 per annum. Successful applicant will be expected to take a responsible part in the engineering drawing and design work of engineering students, and there are prospects of promotion.—Apply in writing to Head of Mechanical Engineering Department, Imperial College, London, S.W.7. E6290

PUBLIC APPOINTMENTS

KUMASI COLLEGE OF TECHNOLOGY

LECTURERS

Applications are invited for the posts of (1) SENIOR LECTURER and LECTURERS IN CIVIL ENGINEERING; (2) LECTURER IN MECHANICAL ENGINEERING.

The College prepares students for the London University B.Sc. Degree in Engineering and for the examinations of the Professional Engineering Institutions.

Applicants should have a Degree or equivalent professional qualification and will be required to teach some of the following subjects:—

(1) Soil Mechanics, Engineering Geology, Surveying Engineering Materials.

(2) Engineering Drawing, Applied Thermodynamics, Mechanics of Machines, Strength of Materials, Metallurgy.

Appointment may be accepted on contract for 5 years or on pension, or arrangements to continue policies initiated under the F.S.S.U. scheme might be made by the College.

Contract salary scales: £2125 by £75 to £2425 p.a. (Senior Lecturer), £1271 5s. by £62 10s. to £2031 5s. (Lecturer), plus a gratuity payable at end of contract at the rate of £12 10s. for each month of satisfactory service. Pensionable and F.S.S.U. salary scales: £1580 by £60 to £1940 (Senior Lecturer), £925 by £50 to £1625 (Lecturer). Point of entry according to experience.

Children's allowances up to a maximum of three at the rate of £50 p.a. per child up to 10 years, and £100 p.a. per child over 10 years in full-time education up to 21 years. Annual leave with free return first-class passages for the member of staff and, conditional on a minimum stay in West Africa, his wife and up to three children under 17 years. Bungalows with basic furniture at low rental are provided. Income tax low

Applications (6 copies), giving age, education, qualifications, experience and the names of 3 referees, should be sent to The Council for Overseas Colleges, 12, Lincoln's Inn Fields, London, W.C.2. Closing date 25th March, 1958. E6311

THE COLLEGE OF AERONAUTICS

DEPARTMENT OF AIRCRAFT PROPULSION

ENGINEER/DEMONSTRATOR

ENGINEER/DEMONSTRATOR required in the Department of Aircraft Propulsion, to work in the fields of combustion, and aviation fuels and propellants. Responsibilities include preparation and supervision (under direction) of students' experimental work on fuel testing techniques, combustion characteristics, and engine-fuel performance, and providing continuity in research projects. Opportunities exist for extending experience. Engineering Degree or equivalent qualification required, and experience of fuel testing and/or combustion rig work an advantage. Salary according to qualifications and experience in scale £600 by £25 to £1000 p.a., with superannuation under F.S.S.U., and family allowance. House may be available.—Applications, giving full particulars of qualifications and experience, and containing the names of three referees, to The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks. E6261

CENTRAL ELECTRICITY GENERATING BOARD

MIDLANDS DIVISION

FOURTH ASSISTANT ENGINEER (ELECTRICAL)

FOURTH ASSISTANT ENGINEER (ELECTRICAL) is required in the Construction Department at Hams Hall "C" Power Station. N.J.B. service conditions, superannuable appointment, salary within Schedule "B," Grade 7, commencing within the range £810–£935 per annum, ultimately rising to £1035 per annum.

Applicants should have had experience of the design and installation of electrical equipment for power stations or similar industrial works. Appropriate technical qualifications will be an advantage. The successful applicant will be required to assist in the supervision of the installation and testing of power station electrical plant.

Apply, quoting the vacancy number 741MD on Form AE6, available from the Establishments Officer, 53, Wake Green Road, Moseley, Birmingham, 13, by 7th March, 1958. E6267

Classified Advts. continued on page 122

PUBLIC APPOINTMENTS

UNIVERSITY OF SYDNEY, AUSTRALIA

LECTURER IN ELECTRICAL ENGINEERING

Applications are invited for the position of LECTURER IN ELECTRICAL ENGINEERING. The successful applicant will be required to assist with the teaching of electronics to students. Honours Degree in Engineering or Physics and experience in vacuum tube and transistor circuits essential.

The salary for a Lecturer is within the range £A1200–£A80–£A1750 per annum, plus cost-of-living adjustment (£68 men, £51 women), and will be subject to deductions under the State Superannuation Act. (The current scale of salaries is under revision.) The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme in cases approved by the University and its bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

The closing date for the receipt of application, in Australia and London, is 5th April, 1958. E6278

L.C.C. DAY COLLEGES

ASSISTANTS, GRADE A

Applications invited for the following posts for work with full-time and part-time day release and evening students, aged 15–18 years. Burnham F.E. salary scale. Assistant Grade A—£475 by £25 to £900 (men), plus London allowance and additions for training and qualifications ; increments within the salary scales for experience.

Application forms from the Principals of Colleges to be returned by 14 March.

HAMMERSMITH DAY COLLEGE, (WITH EVENING DEPARTMENT), 50, Brook Green, W.6 :

ASSISTANT GRADE A, for technical drawing and elementary science.

WOOLWICH DAY COLLEGE (WITH EVENING DEPARTMENT), Vicarage Road, S.E.18 :

ASSISTANT GRADE A, for science and mathematics, up to S.I. level. (326.). E6305

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE

LECTURER

Applications are invited for a post as LECTURER IN MECHANICAL ENGINEERING, commencing 1st September, 1958. Candidates should hold a Degree in Mechanical Engineering or equivalent qualification, have practical experience in industry or in teaching, and should have a special interest in mechanical engineering design. Salary scale, £1200 by £30 to £1350, according to experience.

Further particulars and application form will be sent by the undersigned. Last date for receipt of applications 14th March, 1958.

E. C. SMITH,
Principal.

19th February, 1958. E6274

AIR MINISTRY WORKS DESIGN BRANCH

LONDON

DESIGNER DRAUGHTSMEN

Air Ministry Works Design Branch require in London DESIGNER DRAUGHTSMEN for Bulk Petroleum Storage and Pumping Installations, experienced in one or more of the following : (a) storage tank layout and design ; (b) pump house and plant layout ; (c) development of pipe line schemes ; (d) hydraulic calculations. Technical training to O.N.C. standard required.

Salaries up to £1015 per annum. Starting pay dependent on age, qualifications and experience. Long term possibilities with pensionable and promotion prospects. 5-day week, 3 weeks' 3 days' leave a year. Normally natural born British subjects.

Write, stating age, qualifications, employment details, including type of work done, to any Employment Exchange, quoting Order No. Borough 105. E5049

LONDON TRANSPORT

ENGINEERING ASSISTANTS

London Transport require ENGINEERING ASSISTANTS for Bridges and Structures Office. Applicants should be Graduates or studying for A.M.I.C.E. or be Senior Structural Draughtsmen with several years' experience of design work. Salary range £790–£950, according to qualifications and experience. Free travel, medical examination.

Applications within 7 days to Staff and Welfare Officer (F/EV 670), London Transport, 55, Broadway, S.W.1. E6298

AIR MINISTRY

PURCHASE AND REMOVAL OF GENERATING SETS

Air Ministry invite TENDERS for the PURCHASE and REMOVAL of GENERATING SETS, located as follows :—105kW Blackstone at Haysastle Cross Haverfordwest, Pembrokeshire ; 135kW Blackstone at Thurleigh, Bedfordshire, and 330kW Harland and Wolf at Dumfries.—Apply immediately to Air Ministry, C.19a, Turnstile House, London, W.C.1, for Tender forms. E6312

PUBLIC APPOINTMENTS

WESTERN REGIONAL HOSPITAL BOARD

SCOTLAND

ASSISTANT ENGINEERS

Applications are invited for TWO POSTS of ASSISTANT ENGINEER for electrical and heating duties respectively. Applicants should be Corporate Members of, or have attained the technical standard of Corporate Members of, the Institutions of Electrical Engineers or Heating and Ventilating Engineers respectively, and should have practical and theoretical experience of design, installation and operation and general maintenance, and should be capable of assisting in preparing specifications and estimates and advising generally on the classes of plant in their own particular field, viz. :

(a) Electrical :

Electrical installation, including heating, lighting and power, and

(b) Heating :

Heating, ventilating, hot water, air conditioning, refrigerating, sterilising and pipe work installations in large buildings, laundries, kitchens, &c.

Salary scale, £700 by £25 (3) by £30 (1) by £35 (6) to £1015.

Starting salary may be above the minimum having regard to experience.

The successful applicants will be required to pass a medical examination and all appointments are subject to a deduction at the rate of 6 per cent. for superannuation.

Applications, giving particulars of qualifications and experience, together with the names of three referees, should be lodged with the Secretary, Western Regional Hospital Board, 64, West Regent Street, Glasgow, C.2, not later than 8th March, 1958. E6252

SOUTH-EAST METROPOLITAN REGIONAL HOSPITAL BOARD

REGIONAL ENGINEER'S OFFICE

APPOINTMENTS

Applications are invited for the following superannuable posts in the Regional Engineer's Office. (1) SENIOR ASSISTANT ENGINEER (Mechanical)—salary £1060–£1245. Candidates should possess appropriate professional qualifications and have experience in the preparation of large steam boiler, heating and ventilating and other mechanical schemes. (2) DRAUGHTSMAN (Mechanical)—salary £445 (age 21) to £665. Candidates must have had suitable training, including three years' technical experience in engineering drawing, preferably heating and ventilating ; also site or workshop experience.

Applications, stating age, qualifications and experience, with names of three referees, should reach the Secretary, 11, Portland Place, W.1, by 12th March, 1958. E6314

THE NATIONAL IRANIAN OIL COMPANY

QUALIFIED ENGINEER

The National Iranian Oil Company has a vacancy for a fully qualified ENGINEER, to develop plans and projects for major work such as pipeline, oil refineries, production and distribution installations, loading terminals, &c., and to supervise execution of such plans. Applicants must be Corporate Members of either Institution of Civil Engineers or Institution of Mechanical Engineers or equivalent ; also Fellow of British Petroleum Institute or equivalent. Age limit 55, with 5–10 years in full control of engineering work related to petroleum industry. Salary commensurate with qualifications and experience. Two-year contract with possibility of extension.

Write, giving full details of particulars and experience, to E. Nabavi, 50, Kensington Court, London, W.8. E6322

LONDON TRANSPORT

CIVIL ENGINEERING DEPARTMENT

TECHNICAL ASSISTANTS

London Transport require TECHNICAL ASSISTANTS for Civil Engineering Department, to deal with surveys, design, preparation of drawings and specifications for earth works, bridges, structural works, &c. Salary £400 at age 20, rising to £745 per annum, according to age and experience, with additional payments for recognised qualifications. Good prospects ; opportunities for permanent appointment and promotion on merit ; free travel ; medical examination.

Applications within 7 days to Staff and Welfare Officer (F/EV 671), London Transport, 55, Broadway, S.W.1. E6242

KIDDERMINSTER AND DISTRICT GENERAL HOSPITAL

WORCESTERSHIRE

SEMI-SKILLED ENGINEER

SEMI-SKILLED ENGINEER (Grade III) required at Kidderminster and District General Hospital, Worcs.

Candidates should have good mechanical ability with some knowledge of electricity. Wages £9 7s. 11d per 44-hour week. Whitley Council conditions of service.

Applications to the Hospital Secretary. E6239

PUBLIC APPOINTMENTS

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

MECHANICAL ENGINEERING RESEARCH LABORATORY, EAST KILBRIDE, GLASGOW

ASSISTANT EXPERIMENTAL OFFICER ENGINEER

D.S.I.R. Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, requires ASSISTANT EXPERIMENTAL OFFICER ENGINEER for design and development work on high fluid pressure equipment. Drawing-office, workshop training and experience of general mechanical engineering design essential, experience of high fluid pressure not expected. Knowledge of : (1) Miniature Precision Mechanisms, or (2) Hydraulic Pumps, Valves, &c., or (3) Mechanical Testing Equipment, an advantage. To carry out detailed designs and given opportunity of testing and developing them in laboratory.

Qualifications : G.C.E. (Advanced) in a Science and Maths. subject or Scottish Leaving Certificate with three subjects, including Science and Maths., in higher grade. Over age 22 Pass Degree, H.N.C. in Mechanical Engineering or equivalent expected.

Initial Salary : £370 (age 18)–£510 (age 22)–£800. Houses in East Kilbride for married staff.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C 158/8A. Closing date, 21st March, 1958. E6304

ATOMIC WEAPONS RESEARCH ESTABLISHMENT

WOOLWICH COMMON

ENGINEERS (MAIN GRADE)

ENGINEERS (Main Grade) required by the Atomic Weapons Research Establishment, Woolwich Common, to control staff engaged on either : (a) Production Planning and Production Control, including contribution to the development of prototype electronic equipment. Or (b) Development of Electronic Equipment or Mechanical Devices and the investigation of new and novel manufacturing techniques. A recognised engineering apprenticeship or equivalent training required and Corporate Membership of the Institution of Mechanical or Electrical Engineers. A thorough knowledge of electronic development and/or production methods essential.

Salary : £1400–£1840 per annum. Contributory superannuation scheme.

Postcards for application forms to the Senior Recruitment Officer at A.W.R.E., Aldermaston, Berks. Please quote Ref. A/1555/25. E6243

PUBLIC APPOINTMENTS

METROPOLITAN WATER BOARD

have vacancies for

ENGINEERING ASSISTANTS

(CIVIL, MECHANICAL AND ELECTRICAL)

for operational and maintenance duties and for the construction of new works.

Salary scale £670 (at age 21) to £910 per annum. Commencing salary according to age and experience.

Applicants must have passed or be exempted from passing Sections A and B (or Parts I and II) of the examinations of the Institution of Civil Engineers, Mechanical Engineers or Electrical Engineers. Subject to certain conditions, promotion to the grade of Assistant Engineer (salary scale £945 to £1165 per annum) is automatic upon obtaining Corporate Membership of one of those Institutions. There are good opportunities for further promotion, that being the normal method of filling senior positions.

Housing accommodation may be available at a reasonable rental.

Office hours 9 a.m. to 4.30 p.m. (Monday, 5 p.m.) ; Saturday (when on duty), 9 a.m. to 12 noon. Saturday morning leave according to service. Five-day week to be introduced shortly.

Permanent pensionable posts.

Staff restaurant, sports clubs, &c.

Forms of application from the undersigned, quoting reference E.

S. D. ASKEW,
Clerk of the Board.

New River Head, Rosebery Avenue, E.C.1. E6241

THE INDUSTRIAL GROUP OF

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY

has a vacancy for a

DEPUTY DIRECTOR OF OPERATIONS

at its Headquarters at Risley, Warrington, Lancashire,

who will be responsible to the Director for production matters in the Operations Branch and will control the production factories associated with the Group. He will be responsible for meeting production programmes within the technical limits laid down and for the efficient, safe and economic operation of the various units, which include nuclear reactors, active chemical plants and separation processes.

Experience in the overall control of large-scale production plants and a good degree in engineering, chemistry or physics are essential. Good personal qualities, together with drive and initiative, are required.

Salary will be from **£3,500** *upwards according to ability and experience.*

THE POST IS PERMANENT AND PENSIONABLE.

Suitably qualified persons are asked to write, in confidence, to

THE DIRECTOR OF OPERATIONS,
UNITED KINGDOM ATOMIC ENERGY AUTHORITY,
INDUSTRIAL GROUP HEADQUARTERS,
RISLEY, WARRINGTON, LANCASHIRE

E6244

TENDERS

COUNTY BOROUGH OF GRIMSBY

EDUCATION COMMITTEE

SUPPLY OF WOODWORK MACHINES

TENDERS are invited for the SUPPLY of WOODWORK MACHINES to the Technical Secondary School. Details may be obtained upon application to this office.

When completed, Tenders should be returned to the undersigned in the envelope which will be provided, not later than 10 a.m. on Tuesday, 11th March, 1958.

The Authority does not bind itself to accept the lowest or any Tender.

R. E. RICHARDSON,
Director of Education.

Education Office,
Eleanor Street,
Grimsby,
Lincs. E6263

ADVERTISEMENT No. 12

CITY OF BAGHDAD

BAGHDAD DRAINAGE—MACHINERY CONTRACT NO. M.2

TO MANUFACTURERS OF CENTRIFUGAL PUMPING PLANT

The Baghdad Sewerage Board invites TENDERS for the MANUFACTURE, ERECTION ON SITE and COMMISSIONING of the following equipment :—53 ELECTRICALLY DRIVEN CENTRIFUGAL UNCHOKEABLE SEWAGE PUMPING UNITS in seventeen stations, complete with Auxiliaries, Control Gear and Wiring. The capacity of individual pumping units will depend on the location, but the smallest is 125 and the largest 15,000 Imperial gallons per minute.

The Tender documents and contract drawings may be inspected during normal working hours after February 4th, 1958, at the offices of the Baghdad Sewerage Board, Baghdad, at the Royal Iraqi Embassies in Bonn and Washington, at the Royal Iraqi Legations in Brussels and Rome, and also at the offices of the Consulting Engineers, John Taylor and Sons, Artillery House, Artillery Row, London, S.W.1, and 464, Alwiyah, Baghdad (Tel. 98736).

Copies of the Tender documents and contract drawings may be obtained from any of the abovementioned addresses on payment of I.D. 20 (twenty Iraqi Dinars) or £20 (Twenty Pounds Sterling). This payment will not be returnable and must be made by cheque or Banker's draft payable to the Consulting Engineers.

The Tenders shall be in English and must be accompanied by a deposit of I.D. 5000 (Five Thousand Iraqi Dinars) either in cash or by a letter of guarantee from an approved Bank in Iraq. The Tenders and accompanying documents must be enclosed in a sealed package which shall not in any way indicate the name of the tenderer and must be delivered in Baghdad in accordance with the instructions contained in the documents by 12 o'clock noon local time on the 1st day of June, 1958.

During the time allowed for tendering the Baghdad Sewerage Board reserves the right to amend the documents for the purposes of clarification or modifications in design or contract conditions. Any such amendments will be notified in writing to prospective tenderers.

The Baghdad Sewerage Board does not bind itself to accept the lowest or any Tender.

(Signed) FAKHRI AL FAKHRI,
Chairman of the
Baghdad Sewerage Board.

E5091

AUCKLAND HARBOUR BOARD

NEW ZEALAND

TENDERS FOR CONSTRUCTION OF FREYBERG WHARF

TENDERS are invited for the CONSTRUCTION of a REINFORCED CONCRETE PILED WHARF, having berths for two overseas ships and comprising 24,500 sq. yds. of reinforced concrete deck, steel sheet pile breastworks, stone banks, formation of approaches and services at Auckland, New Zealand.

Contract documents and plans may be obtained from Auckland Harbour Board, Auckland, New Zealand, or William Coward and Co., 3, St. James's Square, London, S.W.1.

Tenders close at Auckland 30th June, 1958.

V. A. C. CHRISTIANSEN,
Secretary.

E5093

NOTICE

MANCHESTER REGIONAL HOSPITAL BOARD

BUILDING AND ENGINEERING CONTRACTS

The Board are prepared to receive, from main Building Contractors and main Engineering Contractors not already on the Board's Approved List of Contractors, applications for inclusion in such List.

Interested contractors should write to the Secretary of the Board, Cheetwood Road, Manchester, 8, for form of application and further details not later than the 15th March, 1958. E6286

TENDERS

METROPOLITAN WATER BOARD

WALTON PUMPING STATION, WEST MOLESEY, SURREY

TENDERS FOR MACHINERY

TENDERS are invited for the following MACHINERY :—

Section I.—Four 3300V. Vertical Spindle, Electrically-driven PUMPING UNITS (two 40 m.g.d. and two 30 m.g.d., all against a total head of 70ft.), including pumps, motors and pipes, &c.

Section II.—Three 3300V. Vertical Spindle, Electrically-driven PUMPING UNITS (one 5 m.g.d. and two 2¼–4 m.g.d., all against a head of 300ft.), including pumps, motors, starters, pipes, valves, &c.

Section III.—Eleven roto-plug type VALVES (two 24in., six 18in., one 12in., two 8in.), hydraulically-operated, electrically-controlled, and appurtenant works.

Section IV.—Three 3300V. Horizontal Shaft ELECTRIC MOTORS and appurtenant works.

Section V.—One 400kW. Diesel ALTERNATOR and appurtenant works.

Section VI.—One 400kW. Gas TURBO-ALTERNATOR and appurtenant works (alternative to Section V).

Section VII.—High Voltage SWITCHGEAR, REMOTE CONTROL GEAR and appurtenant works.

Section VIII.—415V. SWITCHGEAR and appurtenant works.

Section IX.—Two Germanium or Mercury Arc 100kW. RECTIFIERS, D.C. SWITCHGEAR and CONTROL GEAR.

Section X.—Two 3000kVA. and two 750kVA. TRANSFORMERS.

Tender documents and drawings may be inspected at the offices of the Board (Room 235) and copies obtained, after 3rd March, 1958, from the Mechanical Engineer at New River Head, Rosebery Avenue, E.C.1, upon deposit of a cheque for £5 5s. This sum will be returned provided a bona fide Tender is submitted for at least one complete Section of the works and is not subsequently withdrawn. Cheques should be made payable to the Metropolitan Water Board and crossed "Not Negotiable."

Tenders for part only of a Section will not be considered.

Tenders, enclosed in a plain, sealed envelope, addressed to the undersigned and endorsed "Tender for Machinery, Walton Pumping Station," must be delivered at the offices of the Board (Room 122), not later than 12 noon on Wednesday, 4th June, 1958, before which date no Tender will be opened.

The Board do not bind themselves to accept the lowest or any Tender.

S. D. ASKEW,
Clerk of the Board.

Offices of the Board,
New River Head,
Rosebery Avenue,
London, E.C.1. E6265

EDUCATIONAL

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING

BURSARIES IN CONCRETE TECHNOLOGY

Notice is hereby given that the election to BURSARIES IN CONCRETE TECHNOLOGY, tenable as from October, 1958, will take place in June, 1958.

Candidates must hold a Degree in Engineering at the time of taking up the award and must also have a good knowledge of the Theory of Structures.

Bursaries are of the value of £460, out of which the College Tuition Fee of £64 has to be paid ; the amount may be increased to a maximum of £760, depending on the qualifications and length and nature of industrial experience. The Bursary is for the normal College session extending from October until the following June.

The Course will be Postgraduate and Bursars who successfully complete the course will be eligible for the award of the Diploma of the Imperial College (D.I.C.).

Applications must be received on or before 1st June, 1958, by the Registrar, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7, who will, on written request, send full information and application forms. E6292 B

UNIVERSITY OF CAMBRIDGE

DEPARTMENT OF ENGINEERING

POST-GRADUATE COURSE IN CONTROL ENGINEERING

The 1958–59 POST-GRADUATE COURSE in CONTROL ENGINEERING will begin on 7th October, 1958, and will last approximately nine months. This is the fourth course of a series which has been established in order to meet the need of industry for men trained to a high standard in the theoretical principles and practical application of automatic control and to afford opportunity for study of advanced techniques and modern development in the general field of Control Engineering.

The number of students will be limited and applications must reach the Secretary of the Department not later than 1st July, 1958. Candidates should hold a Degree in Engineering or a suitable alternative qualification and have had some practical training and experience. They will be required to attend for interview in Cambridge on or before 15th August, 1958.

Further details and forms of application for admission may be obtained from the Secretary, Cambridge University Department of Engineering, Trumpington Street, Cambridge. E6258 B

EDUCATIONAL

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

BURSARIES FOR POSTGRADUATE STUDENTS

BURSARIES are available for Session 1958–59 to students normally resident in the United Kingdom, for COURSES OF POSTGRADUATE STUDY (not Research) in Chemical, Civil, Electrical and Mechanical Engineering.

The Courses are normally full-time for one year, leading to the award of the Diploma of Imperial College (D.I.C.). Applicants must be Graduates who have spent at least one year away from University since graduation, preferably in industry.

The Bursaries will be of the value of £500 to £700, according to circumstances.

Further information, and forms of application, which must be returned by 17th May, 1958, may be obtained from the Registrar, Imperial College, South Kensington, London, S.W.7. E6291 B

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E721 E

FREE ! Brochure giving details of Courses in Mechanical and Production Engineering, Draughtsmanship, &c., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other professional examinations —E.M.I. Institutes, Dept. E.30, London, W.4. (Associated with H.M.V.). E972 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED

A LEADING BRITISH COMPANY IN MALAYA requires MECHANICAL ENGINEER. Minimum qualifications—H.N.C. and/or Grad. Mech.E. standard, or apprenticeship with studies of O.N.C. standard. Experience on diesel engines. Electrical experience would be an advantage. Duties will include Engineering Office administration, technical sales, service liaison, testing and installation of machinery, and market surveys. Age limits 24–30, preferably single. Initial remuneration according to age and experience. Annual contractual increments, annual bonus out of profits, car allowances and interest-free facilities for car purchase; accommodation provided at nominal rent. Local leave, home leave on full pay on satisfactory completion of tour. First-class passages provided.—Apply, with full details, to BOX No. W1527, Haddon's, Salisbury Square, London, E.C.4. E6283 A

A MEDIUM-SIZE, BUT EXPANDING JOINERY WORKS in West Country (approx. 70 hands) wishes to appoint a SENIOR ASSISTANT to the Production Manager. Duties comprise production planning for entire works, machine loading, work study and rating (in liaison with estimating section), and the introduction and operation of incentive bonus scheme. Production is of comparatively wide variety involving both long and short runs. The post is a responsible one, offering exceptional scope and prospects for a man possessing the requisite experience and capabilities. A good commencing salary will be paid and a staff pension scheme is in operation. Apply, stating age and full details of experience, also remuneration received.—BOX No. E1669, "The Engineer." A

A YOUNG COMMERCIAL ENGINEER required for London office of Pump and Electric Rotating Machinery Manufacturers. Sound prospects.—Reply in writing to Harland Eng. Co. Ltd., 20, Park Street, W.1. E6259 A

APPLICATIONS INVITED FOR

(a) DESIGNER AND DETAIL DRAUGHTSMEN, for general mechanical engineering, pipework, platework, pressure vessels, heat exchangers, &c.
(b) ELECTRICAL ENGINEERING DRAUGHTSMEN, for complete electrical installation and design work, including motor application, control scheme engineering.
(c) REINFORCED CONCRETE DESIGNER, experienced in the design of foundations and structures for heavy industrial plants.
(d) INSTRUMENT DRAUGHTSMEN, for design, selection, installation, commissioning of modern plants for a rapidly expanding instrument department of Chemical Plant Division.

High salaries, pension scheme. Grant towards removal expenses and living allowance until removal is effected.—Apply, The Power-Gas Corporation, Ltd., Stockton-on-Tees. E6147 A

APPLICATIONS ARE INVITED from suitably qualified persons with previous experience as CHIEF PLANNING ENGINEER. This post exists in a medium-sized engineering works, situated in the Tyneside area, engaged in the manufacture of special-purpose plant and machinery covering, in the main, sheet metal work and fabrication of a wide variety of products and machining fitting and assembly. The company enjoys a world-wide reputation as good employers, having been established over a hundred years. Pension and profit-sharing schemes in operation. Salary commensurate with qualifications and experience. Excellent prospects for man with drive and initiative.—BOX No. E1637, "The Engineer." A

ASSISTANT TO ENGINEERING DIRECTOR required for Chemical Manufacturing firm in North London ; H.N.C. or A.M.I.Mech.E. ; duties include design work on new projects, installation of chemical plant, operation of factory services ; previous experience of chemical industry an advantage. Age 25-35 years. Applications, giving full particulars of experience, to Engineering Director.—BOX No. E1671, "The Engineer." A

SITUATIONS VACANT

ASSISTANT WORKS ENGINEER THE DISTILLERS COMPANY LIMITED

The company has a vacancy at its Biochemicals factory at Speke, Liverpool, for an Assistant Works Engineer. Candidates should be aged between 30 and 45 and should preferably hold a University Degree and A.M.I.Mech.E. or A.M.I.Chem.E. They should have considerable chemical plant experience, especially on the installation of new plant and the modification of existing plant. Ability to supervise skilled craftsmen is also necessary.

Duties will include taking charge of the installation of new plant and responsibility to the Works Engineer for the maintenance of existing plant. Salary according to qualifications and experience. Non-contributory pension fund.

Write ;
STAFF MANAGER,
THE DISTILLERS COMPANY LIMITED,
21, ST. JAMES'S SQUARE,
LONDON, S.W.1.
Quote Ref. 16/58. E6205 A

W. S. ATKINS AND PARTNERS ANNOUNCE

that they have a vacancy for a PROGRESS/INSPECTION ENGINEER. Duties will be concerned with a wide variety of equipment as used in the iron and steel and process industries. Applicants should be experienced and able to act on own initiative. Although based in London appreciable travelling is involved.—Applicants should state age, practical experience, technical qualifications and salary required, to Personnel Manager, 158, Victoria Street, London, S.W.1. E6233 A

ASSISTANT WORKS MANAGER required by well-established Paper Converting Company in North West London area. Candidates should be between the ages of 30 and 40 and have a sound mechanical engineering background with at least some knowledge of electricity. They should have also initiative and good administrative ability. The initial salary is up to £1500 per annum, according to qualifications and the prospects are excellent. Apply at first in writing, giving details of previous experience. —BOX No. E10, "The Engineer." A

BAKER PERKINS, LIMITED, Peterborough, seek a PROJECT ENGINEER for development work in their Chemical Machinery Department, which produces batch and continuous Process Machinery for the Chemical, Plastics, Rubber, Foundry and many other industries. Applicants should preferably be Mechanical or Chemical Engineers, aged 23 to 28, holding Graduate Membership of an appropriate Institution or H.N.C. Preference will be given to those with laboratory or production experience in plastics. There are first-class conditions of employment and the company operates pension, life assurance and profit sharing schemes.—Write in confidence with full details of age, experience, qualifications and present salary, to the Personnel Manager, Baker Perkins Limited, Westwood Works, Peterborough, Northants. E6324 A

BRITISH NYLON SPINNERS, LIMITED
require

DESIGN DRAUGHTSMEN

Applications are invited from men who have completed a recognised apprenticeship, have some years of practical experience and, for preference, possess their H.N.C. (H.N. DIPLOMA for Civil Engineering Draughtsmen.) Due to expansion, we are now seeking experienced Civil, Architectural, Mechanical and Services Design Draughtsmen.

These vacancies offer interesting progression, pensionable careers to the right applicants. Excellent working conditions in beautiful surroundings. HOUSES AVAILABLE TO RENT IN THE AREA, AND GENEROUS FINANCIAL ASSISTANCE IS GIVEN TO OFFSET THE COST OF THE MOVE.

Apply in writing, giving full details, to the Personnel Manager, Pontypool, Mon. E6327 A

BRUSH ELECTRICAL ENGINEERING CO. LTD.

invites applications for the position of a
SENIOR RESEARCH & DEVELOPMENT ENGINEER
in their expanding Switchgear Division.

The duties include the development of all new Switchgear with associated investigations and also general research affecting Switchgear and its applications.

Applicants should have had a good engineering education, preferably with a Science Degree and with practical experience in industry.

A good salary will be paid commensurate with this appointment.

Applications, giving particulars of past experience and qualifications, should be addressed to the
Manager, Switchgear Division,
Brush Electrical Engineering Company Limited,
Loughborough,
Leics. E6268 A

CIVIL ENGINEERS AND DESIGN DRAUGHTSMEN with experience of reinforced concrete design, required in the Bristol and other offices of a National Established Engineering Consultancy. These are permanent, pensionable appointments, carrying attractive salaries and, in some cases, accommodation allowance. Reply with full details.—BOX No. E6192, "The Engineer." A

Classified Advts. continued on page 124

SITUATIONS VACANT

CAMEROONS DEVELOPMENT CORPORATION require, for service in British West Africa, an ASSISTANT CIVIL ENGINEER. Preference will be given to candidates holding Parts I and II of the examination of the Institution of Civil Engineers, or the Testamur examination of the Institution of Municipal Engineers. The candidate appointed will have considerable opportunities of widening his experience in a variety of branches of civil engineering and building works. Candidates who have only recently completed their theoretical training will be considered. Commencing salary in the incremental scale £850–£1200. Free passages are provided to and from the Cameroons for officers and their wives, together with free furnished accommodation during residence in the Cameroons. A reasonable amount of free lighting and fuel is also provided, and necessary transport. An outfit allowance of £80 is payable on first appointment, children's allowances are payable up to a maximum of two at the rate of £75 each per annum. Officers are required to contribute 10 per cent of the salary to a provident fund, the Corporation contributing 15 per cent. Tours of about 18 months, with one week's leave on full pay for each completed month of service before returning to the Cameroons.—Applications, giving full particulars, in writing, to Rubber and Mining Agencies, Ltd., 52, Leadenhall Street, London, E.C.3. Acknowledgment will only be made to applications selected for further consideration. E6281 A

CIVIL ENGINEER required by the National Coal Board, for general Civil Engineering work in their East Ayr area, with headquarters in Cumnock. Salary within the range £1050–£1600 per annum, according to qualifications and experience. Qualifications required, A.M.I.C.E. or equivalent, with extensive experience in constructional work.—Applications, stating age, education, qualifications, experience, present post and salary, to the Area Staff Manager, National Coal Board, Lugar Works, Cumnock, Ayrshire. E6303 A

COMMISSIONING ENGINEER for Water Tube Boilers required. Candidates must have technical qualifications of H.N.C. or equivalent and have had experience in the commissioning and operation of power station boilers using P.F. and oil. The successful applicant will be required to take charge of individual sites. The position demands considerable travelling and the applicant will normally be resident on site with visits to Head Office, &c. Please give full details of past experience and qualifications. All replies will be treated in strict confidence.—BOX No. E6323, "The Engineer." A

DESIGN DRAUGHTSMAN required for development work on Marine Controllable Pitch Propeller Installations and Associated Control Systems. This is a permanent and progressive position with an old-established Engineering Company in South East London. Candidates, aged preferably between 25 and 35 years, should have sound practical engineering training and H.N.C. or equivalent.—Apply with full particulars to BOX No. 3HM.5966, A.K. Advg., 212a, Shaftesbury Avenue, London, W.C.2. E6326 A

DESIGN DRAUGHTSMEN required for mechanical design of nucleonic instruments. Pleasant working conditions. A.E.S.D. rates or more, according to experience, ability or qualifications.—Apply, Chief Draughtsman, Isotope Developments, Ltd., Beecham Grange, Aldermaston, Berks. (Tel.: Woolhampton 451). E6295 A

DESIGN ENGINEER required, to understudy Chief Designer. Candidates must have H.N.C. in Mechanical Engineering, considerable design experience on lift or special-purpose equipment, practical machine shop and, preferably in addition, fabrication and light structure experience. The position offers excellent prospects of advancement. A good salary is envisaged for suitable applicant. Bonus and pension scheme in operation ; 5-day week.—Applications, stating age, qualifications, experience, present position and salary, should be forwarded to Marryat and Scott, Wellington Works, Hounslow. E1640 A

DESIGNER-DRAUGHTSMAN required for a small firm on South Coast. Required for work on small machine tools and special-purpose machines. An A.M.I.E.E., A.M.I.Mech.E., or similar qualification would be an asset. Give details of experience and salary expected.—Apply, BOX No. E1635, "The Engineer." A

DEVELOPMENT ENGINEERS.—There are opportunities for men between 25–35 years of age with limited experience in electronics, and a knowledge of inspection procedures. Applicants must be prepared to travel and spend periods away from base.

Knowledge of aircraft is desirable, as duties will include installation of airborne equipment.

A further DEVELOPMENT ENGINEER is required with an Electronics Degree for work in our Vibration Test Section, designing vibration recording equipment.

There will be opportunities for travel and the successful applicant should be fit for flying duties.

Applicants should write, giving full details, to the Personnel Manager (ref. 42), de Havilland Propellers, Limited, Manor Road, Hatfield, Herts. E6289 A

DRAUGHTSMAN required for Development Work on special purpose machinery. Wide knowledge of mechanisms essential. Applicant should be aged 23/25 years and have O.N.C. 5-day week. Sick and pension fund.—Apply in writing to Personnel Officer, Osram Glass Works, East Lane, Nth. Wembley. E6269 A

DRAUGHTSMAN (MECHANICAL) Intermediate.—Wanted for design and planning section of progressive organisation. Excellent prospects. Pension scheme.—Write, Chief Draughtsman, Matisa Equipment, Ltd., Hanworth Lane, Chertsey. E1642 A

DRAUGHTSMEN/CHECKERS required, good mechanical engineering experience essential.—Apply, Personnel Manager, Blaw Knox, Ltd., Esplanade, Rochester, Kent. E1634 A

ENGINEER BUYERS AND REPRESENTATIVES' ASSOCIATION (Limited by Guarantee). The Council of this dominant professional organisation can fill vacancies for Engineer Buyers and Engineer-Representatives (no fees—employers or members)—and to consider application for membership from qualified Buyers and Representatives associated with the Engineering and Allied Trades.—Write E.B.R.A., 47, Victoria Street, London, S.W.1. Tel.: ABB 3583 (Employment Licence No. 6063). Licensed annually by the L.C.C. E627 A

ELECTRICAL DESIGN ENGINEER required. Experience in heavy industrial motors and switchgear essential. Must be able to initiate and develop full electrical control schemes allied to chemical plant. A knowledge of instrument electrical control systems an advantage.—Air Products (Great Britain), Ltd., 9, Upper Belgrave Street, London, S.W.1. E1652 A

ELECTRICAL ENGINEER required, for group engineering staff of expanding rubber company. Must possess minimum of five years' electrical design and maintenance experience. Knowledge of electronics desirable.—Write, giving brief details of experience and salary requirement, to Chief Engineer, The Avon India Rubber Co., Ltd., Melksham, Wilts. E6182 A

ENGINEER
required in
DEVELOPMENT LABORATORIES
for stress analysis and vibration problems.

Applicants should have a good Degree in Mechanical Engineering, together with ability to make a mathematical approach to problems. Some experience in industry and in the use of electronic equipment is desirable.

The position carries an attractive starting salary and provides excellent opportunities for further advancement. Staff pension fund.

Apply in writing, stating age, qualifications and experience, to the Personnel Manager, JOSEPH LUCAS (ELECTRICAL), LIMITED, Great King Street, Birmingham, 19, quoting reference PM/D/192. E996 A

ENGINEER.—A vacancy exists in the Atomic Energy Division of the G.E.C. for a MECHANICAL or STRUCTURAL ENGINEER interested in theoretical, structural and stress analysis, and structural design. Candidates need not necessarily have experience in this type of work, but a University Degree or its equivalent is essential. This post is ideal for an imaginative young man interested in entering a new and rapidly expanding industry.—Apply, Personnel Manager (D.B.), The General Electric Company Limited, Erith, Kent. E6299 A

ENGINEER REQUIRED for WEST AFRICA, for Operation and Maintenance of Vegetable Oil Producing Factory. Candidates, aged 26–33, must be of good education, at least qualified by examination for A.M.I.Mech.E. or equivalent, with good practical operating experience in charge of steam boilers and engines ; also diesel engines and plant maintenance, including small electrical installations. Post is one of responsibility for efficient processing, control of staff, training of Africans and includes upkeep of transport vehicles. Commencing salary would depend on qualifications and experience. In addition there are family allowances ; free furnished accommodation ; membership of pension fund ; free first-class passages to and from Africa and free medical attention in Africa. Tours of about 21 months are each followed by substantial leave on full pay. Please apply, giving all details of qualifications and experience.—BOX No. E6187, "The Engineer." A

ENGINEER SURVEYOR, not over 38 years of age, must hold First Class M.O.T. Certificate (Steam) or equivalent for Inspection Boiler and Pressure Plant. Salary £735 to £1060 (E.S.A. Scale). Non-contributory pension and other benefits. Areas N.W. London, S.W. England, S. Wales.—General Accident Fire Life Assurance Corporation, Ltd., General Buildings, 99, Aldwych, W.C.2. E6325 A

ENGINEERS WITH IDEAS are wanted by Ardente Acoustic Laboratories, Ltd. There is an interesting job for a qualified Graduate Electronic Engineer, to work on the development of miniature transistor amplifiers and miniature electronic components. Our Engineers have a great deal of freedom in the design of these products and are able to carry their ideas through to the production stage. This post carries an attractive salary.—Write, BOX E 791, L.P.E., Romano House, 399/401, Strand, London, W.C.2. E6240 A

ESTIMATING AND PROPOSAL ENGINEER
required
for large, progressive Heavy Engineering Company in North East England. Applicants should be suitably qualified and preferably have had experience in connection with turbo-generating and associated plant. The post offers good salary and prospects.

Applications are invited.—BOX No. E6306, "The Engineer." A

FABRICATION DESIGN ENGINEER

Davy and United Engineering Company Limited, engaged in the manufacture of heavy capital equipment for the Steel Industry, invites applications for the position of Fabrication Design Engineer. Applicants should have the Higher National Certificate in Mechanical Engineering, experience of the design of heavy engineering weldments with plate up to 4in. thick, a wide experience of fabricating shop practice and the development of economic welding design.

Good conditions, contributory superannuation scheme, canteen facilities.

Apply, with details of age, experience, qualifications, &c., mentioning this newspaper, to : Personnel Department, Davy and United Engineering Company Limited, Prince of Wales Road, Sheffield, 9. E6301 A

ESTIMATING ENGINEER required for Oil Refinery and Chemical Plant Contractors. Applicants must have drawing-office experience and wide knowledge of refinery layout, also must be capable of working to preliminary plot plans and flow sheets. Minimum standard of education : H.N.C. or equivalent.—Write fully, stating age and experience, Staff Manager (EE.2.), Foster Wheeler Limited, 3, Ixworth Place, London, S.W.3. E6231 A

ESTIMATOR for progressive position with prominent London firm of land and marine boiler engineers. Drawing-office experience essential ; workshop experience an advantage. Attractive salary commensurate with experience and qualifications.—Write fully, stating age, &c., BOX No. 1525/SE2, c/o Charles Barker and Sons, Ltd., Gateway House, London, E.C.4 E6232 A

FOSTER WHEELER, LIMITED,
Marine Boiler Department

ENGINEERS required for design work on new projects and developments. Qualifications should include B.Sc., H.N.C. or A.M.I.Mech. or Mar.E. Previous experience of heat transfer or pressure vessel work desirable, but not essential. Age range, 25–35 years. Salary according to qualifications, and good prospects. Pension fund.—Write fully, Staff Manager (MB.3), Foster Wheeler, Limited, 3, Ixworth Place, London, S.W.3. E6186 A

INSTRUMENTATION ENGINEER, experienced in the design and supervision of major electro-pneumaitc installations in connection with the chemical and oil refining industry. This position carries long-term prospects. Commencing salary up to £1500 p.a.—Please reply, giving full details of experience and qualifications, to BOX No. E6317, "The Engineer." A

JOSEPH LUCAS (ELECTRICAL), LIMITED,
have vacancies for
ASSISTANT DEVELOPMENT ENGINEERS
to work on the design and development of automobile generators, alternators and starting motors and also of motor-cycle electrical equipment, including equipment to be used for racing purposes. Applicants should be of Higher National standard and should have had previous experience in electrical design. Five-day week, staff pension fund.

Apply in writing, stating age, qualifications and experience, to the PERSONNEL MANAGER, JOSEPH LUCAS (ELECTRICAL), LIMITED, Great King Street, Birmingham, 19, quoting reference PM/D/176. E995 A

JOSEPH LUCAS LIMITED have a vacancy for a CHARTERED CIVIL ENGINEER between the ages of 30 and 40. He will be responsible for the company's building projects in various parts of Great Britain. The buildings in question may be factories, administration blocks, laboratories or engineering schools ; there will also be alterations and extensions to existing buildings. He will act as the company's representative in negotiations with architects and building contractors and will be responsible to the company for progress of contracts and interim and final payments to contractors. A number of years of experience with a large firm of building contractors is essential and some additional mechanical and electrical engineering knowledge is an advantage. A high salary and attractive pension arrangement is available for a first-class man who is capable of doing this job.—Applications should be made in writing to the Personnel Manager, Joseph Lucas (Electrical) Limited, Great King Street, Hockley, Birmingham, 19. E6275 A

MECHANICAL DESIGNER sought by established manufacturer, in London, with world market for special-purpose precision machinery. Exceptional prospects for Qualified Mechanical Engineer having practical experience, aged 30–40, who is possessed of the "creative spark." Only applicant fertile in ideas, with original and inventive mind and receiving recognition in his present post on this account, need apply.—Write, in confidence, Personnel Manager, Molins Machine Co., Ltd., Evelyn Street, London, S.E.8. E6188 A

MECHANICAL ENGINEERS. Vacancies exist within the following categories, determined by qualifications :

1. Extra first-class M.O.T. Certificate, or University Degree, with experience of boilers and engines—upper age limit 35.
2. University Degree with interest in design and construction of pressure plant, including that for nuclear and other power stations—age range 26–32.

Progressive salary with non-contributory pension.—Apply in own handwriting to British Engine Boiler & Electrical Insurance Co. Ltd., 24, Fennel Street, Manchester, 4. E6276 A

MUNICIPAL MUTUAL INSURANCE LIMITED has vacancies for ENGINEER SURVEYORS in London, Birmingham, Bradford and Manchester. Posts are pensionable and permanent to satisfactory candidates, who should have served an apprenticeship and have sound practical and theoretical knowledge. Technical qualifications : First Class Ministry of Transport Certificate. Salary : £735–£1060 per annum.—Apply in own handwriting, marking the envelope "Application Engineer Surveyor" and "Private and Confidential," to the Chief Engineer, 22, Old Queen Street, Westminster, S.W.1. E6310 A

MECHANICAL DRAUGHTSMAN. — Large commercial and industrial organisation has vacancy in London head office for a Senior Mechanical Draughtsman. Applicants must have had extensive experience in layout of machinery and boilers, and possess a good all-round knowledge of general engineering. Some building experience would be an advantage. For the right man the prospects are excellent and there is a non-contributory pension scheme.—Write, giving age and details of experience, to BOX No. E6321, "The Engineer." A

MECHANICAL ENGINEERS required, for group engineering staff of expanding rubber company. Only those applicants with a minimum of five years' experience in a responsible position will be considered. Responsibilities include layout, design, estimating and installation supervision.—Write, giving brief details of experience and salary requirement, to Chief Engineer, The Avon India Rubber Co., Ltd., Melksham, Wilts. E6181 A

NORRIS INDUSTRIAL CONSULTANTS, LIMITED,
require, for their Bristol Head Office
experienced

1. (a) STRUCTURAL ENGINEERS, Reinforced Concrete or Structural Steelwork.
   (b) MECHANICAL HANDLING ENGINEER. Initial salaries within range £900–£1100 p.a.
2. (a) REINFORCED CONCRETE DESIGNER DRAUGHTSMEN AND DETAILERS.
   (b) STRUCTURAL STEELWORK DESIGNER-DRAUGHTSMEN AND DETAILERS. Initial salaries up to £875 p.a.

Permanent positions, pension and insurance schemes.—Write :
Personnel Manager,
Beacon House, Queens Road,
Clifton, BRISTOL, 8. E6315 A

OLD-ESTABLISHED PROGRESSIVE WEST OF ENGLAND FIRM requires ASSISTANT WORKS MANAGER. Good general engineering training and knowledge modern structural methods essential.—BOX No. E6287, "The Engineer." A

PRODUCTION ENGINEER. The United Glass Bottle Manufacturers, Limited, Charlton Works, London, S.E.7. Our Charlton works, one of the largest in the company, and employing over 2000 people, requires a Production Engineer, age 30–40, to assist the superintendent of a shop engaged in the manufacture of high-precision mould equipment for the production of glass bottles in their factory, and others within this nation-wide group. The minimum qualification is H.N.C., preferably A.M.I.Prod.E. or A.M.I.Mech.E., and applicants should have a comprehensive knowledge of modern machine shop production techniques with at least five years' experience in a responsible supervisory role. The post is pensionable, offers excellent scope for drive and initiative, carries good prospects for future advancement and an attractive starting salary commensurate with the responsibilities involved.—Please write, giving full details of age, qualifications, experience and salary envisaged, to The Personnel Officer, The United Glass Bottle Manufacturers, Limited, Anchor and Hope Lane, Charlton, London, S.E.7. E1670 A

PRODUCTION ENGINEER and Assistant to the Managing Director required by small progressive engineering firm. Excellent opportunity for young engineer with initiative, and willing to accept responsibility.—BOX No. E6084, "The Engineer." A

PUBLICITY DEPARTMENT

A competent man is to be appointed by an important firm in the field of building and engineering materials in the Manchester area. He should have experience of technical advertising and publicity in an industrial concern and be conversant with the preparation and supervision of printed matter, exhibitions, editorials, &c. Initial salary dependent upon age and capabilities but not less than £800 p.a., with every prospect of progressive advancement.—BOX No. E6297, "The Engineer." A

REQUIRED, DRAUGHTSMAN, with experience in industrial diesel locomotive design. Must hold H.N.C. or similar. Vacancy is in London area.—BOX No. E6288, "The Engineer." A

RESIDENT ENGINEER REQUIRED for mechanical and plant erection work on new oil refinery and chemical plant construction. Should be experienced in use of heavy lifting equipment, pipelines, &c., and control of labour. Commencing salary up to £2000 p.a., according to experience and qualifications. Please write in confidence, giving full details of past employers and contracts carried out.—BOX No. E6320, "The Engineer." A

RICHARDSONS WESTGARTH (HARTLEPOOL) LIMITED
require
DRAUGHTSMEN

There are vacancies on the permanent staff in the Hartlepool and London Offices for Draughtsmen with mechanical or electrical engineering experience in connection with either general arrangement or detail drawings.

Special consideration will be given to applicants with experience of turbo-generating and associated plant, but there are also openings for suitable men with a background of heavy mechanical or electrical engineering.

These vacancies, in an expanding company, offer first-class opportunities, good salaries and conditions.

Write, in strict confidence, quoting reference H.–2, to the Group Personnel Officer, Richardsons Westgarth and Co., Ltd., G.P.O. Box 2, Wallsend on Tyne. E6308 A

SENIOR DESIGN ENGINEERS AND DESIGN DRAUGHTSMEN, experienced in industrial electronics or light precision mechanisms, required for permanent appointments in London, Bristol and the Home Counties. Salary and allowance in the range £900–£1200 per annum. Pension scheme.—BOX No. E6316, "The Engineer." A

STRUCTURAL DRAUGHTSMEN AND CHECKERS required in South West England. Good conditions. Pension scheme. Apply.—BOX No. E6234, "The Engineer." A

BOOKS and PUBLICATIONS

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ELECTRICAL ENERGY offers a distinctive service to its readers. It is a monthly technical journal designed to provide them with accurate and up-to-date information exclusively about those matters which concern them as electrical engineers.

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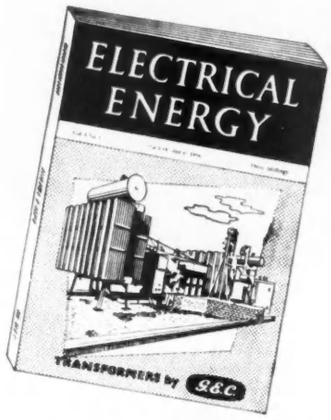

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SITUATIONS VACANT

SALES ENGINEER.—A well-known company manufacturing a specialised engineering component, has a vacancy for a REPRESENTATIVE. The person appointed will be based in or near Manchester and expected to take full Sales responsibility in a designated area in the N.W. of England. He must initiate, foster and develop such relations with customer firms in his area as will maintain and increase Turnover with them, and feed back to headquarters information on which general sales policy can be based. Some knowledge of engineering is needed and experience of the engineering industry would be useful. Stress is laid on general maturity of outlook and behaviour and while previous sales experience is useful, the post might appeal, among others, to Officers of Field Rank leaving the Armed Forces to seek a career in industry. Preferred age range 28–35, though exceptional candidates outside this range considered. A starting salary of up to £1300 per annum will be paid and the job itself provides opportunities to earn up to £1500. A car and expenses will be provided. Besides providing satisfying and remunerative responsibilities in itself, this post also offers a good route to higher level appointments.—Applications, which will be treated in strict confidence, should be sent to BOX N M7512, A.K. Advg., 212a, Shaftesbury Avenue, London, W.C.2. E6294 A

SECTION LEADER, ELECTRICAL DRAWING-OFFICE
required by The Steel Company of Wales, Ltd. (Steel Division), Port Talbot.

The successful candidate will be expected to take charge and supervise an office of fifteen electrical draughtsmen. He should have experience in heavy industry and be capable of preparing drawings for electrical installations, including the layout of sub-stations and contactor rooms. A knowledge of lighting and communications would be an advantage.

Higher National Certificate or equivalent desirable.

Those wishing to apply should write, giving full details of age, experience, qualifications and present salary, to :

Superintendent, Personnel Services,
THE STEEL COMPANY OF WALES, LTD.
(Steel Division),
Abbey Works,
PORT TALBOT, Glam. E6313 A

SENIOR MECHANICAL/ELECTRICAL ENGINEER required by Westminster consulting engineers specialising in main drainage and water supply. Experience of pumping plant, electric motors, switchgear, large diesel and dual-fuel engines essential. Five-day week, pensions scheme.—Apply in writing to J. D. and D. M. Watson, MM.I.C.E., 18, Queen Anne's Gate, S.W.1. E6256 A

SENIOR MECHANICAL ENGINEERING DRAUGHTSMAN required, for equipment design and layout in drawing-office of expanding rubber company. General engineering experience and knowledge of special-purpose machinery design desirable. Education, H.N.C. preferred, O.N.C. acceptable.—Write, giving details of experience, age and salary required, to Chief Engineer, The Avon India Rubber Co., Ltd., Melksham, Wilts. E6180 A

TECHNICAL ENGINEERS

Applications are invited from Engineers, with Degree or equivalent qualifications, who are familiar with the design and construction of rotating machinery.

The company, engaged in Heavy Engineering, operates in North East England, and its most progressive outlook offers first-class posts and encouraging prospects to the right man.

Applicants should send details of qualifications and experience.—BOX No. E6307, "The Engineer." A

TECHNICAL REPRESENTATIVES required for Portable Tools, all areas. Sound engineering background.—Apply, giving particulars, to Sales Manager, Armstrong Whitworth Co. (P.T.), Ltd., 40, Broadway, Westminster, S.W.1. E6300 A

THE G.K.N. GROUP RESEARCH LABORATORY requires a PHYSICIST or METALLURGIST, preferably with electrical experience, to control projects in the welding field. The post requires a capacity for original work and the exercise of initiative. The laboratory serves all the companies of a large group, and is well equipped for fundamental research and development. Ample opportunity exists for contact with Group companies, and research activiites are extending. Applicants, who should be of Degree standard, are assured of good working conditions. Salary scales are attractive.—Please write to the Director of Research, G.K.N. Group Research Laboratory, Birmingham New Road, Lanesfield, Wolverhampton, and quoting reference EE/W/3. E6319 A

WANTED, ENGINEER/SUB-AGENT, to understudy and shortly take over post as Excavation Manager. Must have good experience latest methods and modern equipment and interest in maintenance. Interesting and varied work covering all aspects of contracted earth-moving and ancillary work. Commence approximately £900, according to experience, with good prospects of early advancement. Superannuation scheme, &c.—BOX No. E6251, "The Engineer." A

WANTED, WORKING ENGINEER with experience in the maintenance of all engineering services, including steam and low-pressure hot water, oil firing and laundry machinery. House available.—Apply to the Bursar, Haileybury and Imperial Service College, Hertford, with references. E6284 A

WORKS MANAGER.—First-class Precision Engineer, with proven managerial experience, required by old-established public company in light precision work and optical instruments, binoculars, &c., at their S.W. London factory. Excellent living accommodation available if required. Applicant must have extensive experience of planning, production, estimating and factory costing, and be able to take overall control of approximately 450 employees and all works activity. Substantial surplus capacity is available in machine shops, tool room, metal finishing and assembly shops. Unique opportunity for fully experienced man with ideas and initiative. Starting salary envisaged not less than £1500 p.a., with excellent prospects.—Reply, in confidence, stating age, experience, references and present salary, to Managing Director, Ross, Ltd., Clapham Common, London, S.W.4. E1672 A

SITUATIONS VACANT

WORKS DIRECTOR REQUIRED by well-established, progressive company specialising in mechanical handling equipment for mines and quarries. Applicants must be experienced engineers and trained in modern methods of production and administration. Excellent prospects for keen man. Age preferably 35/40, although consideration would be given to older applicants with exceptional ability. London area. Reply, stating qualifications, experience, commencing salary required and age.—BOX No. E1668, "The Engineer." A

WORK STUDY ENGINEERS

Ashmore, Benson, Pease and Company require Work Study Engineers for standards development in the machine shops (floor area about 150,000 sq. ft.) which form part of new workshop extensions.

The staff appointed will form part of a team of engineers working on the planning, progress and shop loading system who, on completion of the development work, will transfer to the production engineering staff.

Applicants should have a thorough training in work study techniques and experience of applying them to general engineering work in heavy and medium machine shops.

Engineers interested in joining the team on this project should write stating qualifications and salary required, to : Staff Personnel Manager, Ashmore, Benson, Pease and Company, Stockton-on-Tees. E6238 A

MSL have been retained to advise on the appointment of a

CONTRACTS AND MAINTENANCE ENGINEER

for one of the largest manufacturers of footwear in the country with 6,000 employees. The factories are situated in delightful non-industrial countryside in the South West.

The Contracts and Maintenance Engineer will be responsible for all maintenance of buildings, plant and machinery at the company's main factory, and will undertake contracts for alterations and extensions to the company's subsidiary factories. He will control about 180 staff, technicians and tradesmen. There are excellent prospects of promotion within five years.

Candidates should have a good honours degree in engineering, followed by graduate training in industry and preferably some experience of managing a maintenance department in a process industry. Age 28 to 34.

Remuneration not less than £2,000 per annum.

No information will be disclosed to our clients until candidates know their identity and have given permission after personal discussion. Please send brief details in confidence, quoting reference G.664, to G. K. Dickinson.

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1.

E6245 A

DESIGN ENGINEERS

required

for Development Section of Drawing Office engaged on forward projects for Mining, Crushing and Earth-moving Machinery. Experience in any of these branches would be an advantage but is not essential. These are Senior positions and applicants must have initiative and be capable of working with minimum supervision. Prospects are excellent, in a long-established and expanding company.—Applicants should give full details of age, career, experience and technical qualifications, with salary required. Address applications to the Secretary, British Jeffrey-Diamond, Ltd., Stennard Works, Wakefield.

E6282 A

Classified Advts. continued on page 126

SITUATIONS VACANT

TECHNICAL MANAGER
FOR
TRANSFORMER FACTORY
IN
SOUTH AFRICA

A Technical Manager is required by Johnson & Phillips, Ltd., for a small but expanding Transformer Factory in the Union of South Africa. Applicants for this important appointment should have a good technical background, preferably with both design and production experience and a sound understanding of the transformer industry. — Detailed applications, which will be treated in the strictest confidence, should be sent to the General Manager, Overseas Department, Johnson & Phillips Ltd., Victoria Way, Charlton, London, S.E.7. E6257 A

SITUATIONS VACANT

ASSISTANT CIVIL ENGINEER

Applications are invited for the position of an Assistant Civil Engineer, to be engaged in the construction of a large nuclear power station. Preference will be given to applicants with experience in setting out. Please write, stating age, qualifications, experience and present position. — BOX No. E6255, "The Engineer." A

SITUATIONS VACANT

STRUCTURAL ENGINEERING ASSISTANTS

are required by

SCOTT AND WILSON, KIRKPATRICK AND PARTNERS

CONSULTING CIVIL AND STRUCTURAL ENGINEERS,
47, Victoria Street,
Westminster, S.W.1,

for the following appointments :—

(1) STEELWORK DESIGNERS for London office.

(2) REINFORCED CONCRETE DESIGNERS for London office.

Candidates for these appointments should be preferably Corporate Members of the Institutions of Civil or Structural Engineers, and should have had at least three years' practical experience in the design and detailing of steel or reinforced concrete structures.

Starting salaries will be graded according to age and experience. Luncheon vouchers, pension scheme and five-day week pertain to the appointments, which carry good prospects.

Applicants are invited to write in confidence to the above address, stating age, professional qualifications and full details of experience. E6280 A

SITUATIONS VACANT

COLGATE-PALMOLIVE LIMITED
require

A qualified Engineer to take charge of design drawing office, handling plant layouts, special purpose machine design, chemical plant, pressure vessels, mechanical handling equipment, &c. Previous experience in the control of D.O. staff essential. Applicants must have served a recognised apprenticeship and hold at least the H.N.C. in Mechanical Engineering. A good salary is offered and working environment and amenities are excellent.—Write in confidence to Factory Personnel Manager, 371, Ordsall Lane, Salford, 5, with all relevant information. E1663 A

PIPING DESIGNER/DRAUGHTSMEN

Kellogg's design capacity increased substantially in 1956 compared with 1955. In 1957 it was more than double that of 1955. This indicates that we offer the oil and chemical industries *something* to account for these increases in the volume of our work and in the size of our staff to handle it. That "something" is greater process know-how, more solid design experience, speed and efficiency, and a record of achievement in our business of which we are proud. If you are qualified, you can join our team. Our knowledge and our high standards of engineering work will then help in your own development !

Our Piping Designer/Draughtsmen are of a high standard and we therefore can consider only men of equal calibre.

Our permanent Staff benefit from above average salaries, liberal personnel benefits, good working conditions, excellent Social Club, etc.

If you qualify and are interested you are invited to write to, or telephone, the Personnel Manager,

KELLOGG INTERNATIONAL CORPORATION 7-10 CHANDOS STREET, LONDON, W.1.
Telephone : MUSeum 4010.

quoting reference No. 123/G.

E6160 A

B.I.C.C. LTD, LEIGH,

have the following vacancies :—

MECHANICAL ENGINEERING AND PLANT LAYOUT DRAUGHTSMAN, 25/35 years of age, with good engineering background. Experience in general cable-making machinery detailing and/or cable factory plant and services layout, whilst not being essential, would be an advantage. Five-day week. Salary A.E.S.D. plus, according to qualifications and experience.

DESIGNER-DRAUGHTSMAN IN THE PLANT DEVELOPMENT SECTION, RUBBER CABLES DIVISION, for work in prototype machines, &c. Appointment offers excellent prospects to a man with a flair for design work and capable of following the projects to a production stage with minimum supervision. Applicants, preferably between the ages of 30/40 years. Mechanical Engineering qualification to H.N.C. standard (or equivalent) would be an advantage. Five-day week.

Written applications, stating salary required, age, experience and qualifications, should be addressed to the Personnel Officer, British Insulated Callender's Cables, Ltd., Anchor Works, Leigh, Lancs.

E6266 A

FIRST-CLASS OPPORTUNITIES FOR DESIGN ENGINEERS

A limited number of vacancies will very shortly arise with B.I.C.C. Ltd., at their Prescot Works, for Engineers qualified to degree standard with a sound knowledge of Drawing Office and Workshop Practice, to undertake specific projects involving original work on the design of low and medium voltage switch and fusegear. Each engineer will operate with a team of competent draughtsmen in a position of seniority offering considerable scope for initiative and enterprise.

The importance of the positions is reflected in the excellent salaries to be offered, which will be in the four-figure range. In addition, there are good prospects for advancement, and conditions of employment are excellent.

Applications, quoting reference P/21, should be addressed to :

The Works Personnel Officer,
British Insulated Callender's Cables, Ltd.,
PRESCOT, Lancashire.
Tel.: Prescot 6571.

E6200 A

JOSEPH LUCAS LIMITED

ENGINEERS OR METALLURGISTS FOR GROUP WELDING LABORATORY

. . . required to assist in the development of advanced welding processes for application to the Group's road transport, aircraft, and gas turbine products.

Applicants should have engineering and metallurgical background with Higher National Certificate or equivalent.

The commencing salary will be substantial, commensurate with experience and qualifications and there will be ample scope for advancement in an expanding department.

The positions are permanent and pensionable. Apply in writing, stating age, qualifications and experience to the Personnel Manager, Joseph Lucas (Electrical), Limited, Great King Street, Birmingham 19, quoting reference PM/D/177.

E6144 A

SPECIAL ROCKET PROJECTS

BRITISH OXYGEN WIMPEY LIMITED

who are engaged on interesting work of vital, national importance, invite applications from :—

DESIGNERS AND DRAUGHTSMEN

with experience in any of the following types of work :—Chemical Plant, Pressure Vessels, Pipework, Instrument or Electrical Layout.

These are well-paid, permanent and progressive posts with a comprehensive pension scheme. Financial aid will be given to new staff wishing to move their homes to the London area. Interviews can be arranged after office hours, if necessary.

Apply, with details of age and qualifications, experience and present salary, to the Office Manager, British Oxygen Wimpey, Ltd., 17, Monck Street, London, S.W.1 (Tel.: Victoria 6811).

E6270 A

SITUATIONS WANTED

A.M.I.C.E., M.I.MECH.E., aged 41. Keen, energetic, recently returned to U.K., where permanent progressive post now sought. Experience contractors' plant, pumping and electrical installations, works management, stores, contract administration. —BOX No. E1656, "The Engineer." B

ENGINEER (29), H.N.C., G.I.Mech.E., 5 years' contracts, estimating and liaison experience pump and metering installations, seeks Similar Post or Technical Representative, London or South.—BOX No. E1664, "The Engineer." B

SENIOR EXECUTIVE

Electrical Engineer (Member, A.I.E.E.), with extensive mechanical experience, with outstanding record of sales and organisation successes, speaks, writes fluently English, French, Spanish German, at present heading important North American manufacturing and sales enterprise in the electro-mechanical field, seeks new challenging position abroad.—BOX No. E1660, "The Engineer." B

PRODUCTION ENGINEER (40), H.N.C., seeks progressive post. 7½ years toolroom, 5 years Jig and Tool draughtsman, 3 years works foreman, 5 years planning engineer, high precision instrument work. Sussex area preferred.—BOX No. E1667, "The Engineer." B

BUSINESS OPPORTUNITIES

CONSULTING ENGINEER in Victoria Street seeks Association with Independent Structural Engineer. Furnished office and secretarial facilities provided.—BOX No. E1661, "The Engineer." O

HIGHLY REPUTABLE ENGINEERING FIRM, old established, and contractors to H.M. Government, have capacity available for, preferably, complete Manufacture of Additional Line, or, alternatively, Sub-Contract Work involving Grey Iron Castings up to 1 ton weight. Own pattern, foundry, machining and assembly shops. Manufacture under licence or royalty considered.—BOX No. E1591, "The Engineer." O

VALVES.—Engineers with capital willing to Purchase Controlling Interest in Company manufacturing Valves. Replies will be treated in strictest confidence. —BOX No. E1666, "The Engineer." O

WANTED, New Products by a Canadian engineering company for manufacture and/or distribution in Canada. Licensing arrangement considered. Principals only.—Metro Engineering Co., Ltd., 102, Elmslie Street, Montreal, 32, Quebec, Canada. E1631 O

BUSINESSES and PREMISES

AUCTION SALE, 10TH MARCH, 1958
336/338, BRIXTON ROAD, LONDON

Occupying a valuable main road position within two miles of Westminster Bridge. SINGLE-STOREY FACTORY and BUSINESS PREMISES, with extensive frontage and forecourt of 3000 square feet. Floor space 12,300 square feet. Entrances from road to rear.

Auctioneers : D. R. Werner and Co., 10, Norfolk Street, London, W.C.2. TEMple Bar 5161. E1649 L

AGENCIES

AGENTS required by material handling and aircraft ground servicing equipment manufacturers, all parts. On commission basis.—BOX No. E1627, "The Engineer." D

INTERNATIONAL CONCERN of the welding industry offers Sole Agency for Great Britain for the sale of special alloys and electrodes, well established on the Continent. Patented methods of application, technical training provided. Applicants to be firms only well introduced to the British industry. £5000 for keeping regular stock required.—BOX No. E1665, "The Engineer." D

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone Byron 1178). E575 MW

DRAWING-OFFICE CAPACITY AVAILABLE for the design and/or detailing of material handling and structural contracts. Enquiries welcomed and promptly dealt with.

C. G. BARKER, LTD.,
60, Lowfield Street,
Dartford, Kent.
(Tel.: Dartford 2626). E1604 MW

E.M.C. ENGINEERING CO. (LONDON) LTD.
SOUTHEY WORKS, SOUTHEY ROAD, TOTTENHAM, N.15. TEL. STA 2069.

PRECISION MACHINING CAPACITY
Centre Lathe, Capstan, Milling, Shaping, Drilling, Tapping, Assembling, Jigs, Fixtures and Press Tools. A.I.D. and A.R.B. Approved. E953 MW

KELLERING and Profile Milling in all metals. Send us your die blocks to copy from wood or plaster masters. Up to 5ft. by 8ft. max. size. We are die copiers to the trade.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Tel.: Knottingley 2743/4). E948 MW

PRECISION ENGINEERS.—Personal service for prototypes, small quantity machined parts and equipments. Design and development undertaken. A.I.D. Approved.—Bowyer, Smyth and Partners, Ltd., Vineyard Walk, Clerkenwell, E.C.1 ('Phone TERminus 5113/4). E650 MW

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The Specialist Foundry
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BLACKHEART MALLEABLE IRON CASTINGS
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HEAT AND ABRASION RESISTING ALLOY CASTINGS
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'PULMAC'
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LUTTERWORTH, Nr. RUGBY
Tel. 10, 60 & 152 E985 MW

PATENTS

THE PROPRIETOR of British Patent No. 685,723, entitled "Spring Forming Machine," offers same for Licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 14, E. Jackson Boulevard, Chicago, 4, Illinois, U.S.A. E6169 H

MISCELLANEOUS

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A.S.P. (ENGINEERS), LTD., 129, Balham High Road, London, S.W.12 (Balham 3426), specialist photographers for the engineering industry. Photographic Work Undertaken, London Area, and 100 miles radius—architectural features, civil engineering and building work, machinery, models and transport, etc. Specimens available on request. E1630 I

TIME RECORDERS, Sales, Rentals, Service, Telephone Hop 2239.—Time Recorder Supply and Maintenance Co., Ltd., 157-159, Borough High Street, London, S.E.1. E608 I

FOR HIRE

LATTICE STEEL Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1 ('Phone, SLOane 5259). E112 K

MACHINERY Etc. WANTED

BALL AND ROLLER BEARINGS, &c., WANTED ! Also Surplus Goods—especially Hand Tools—of All Descriptions.

FOR SALE : METAL BOXES of strong and sturdy gauge and construction, with Handles, in all sizes. Ask for details.

R. PORDES
138, NEW CAVENDISH STREET, LONDON, W.1.
MUSeum 5250. E6271 F

LATHE to swing 45in. over the saddle, admit 20ft. between centres, motorised for 400/440/3/50 cycles supply.—BOX No. E6273, "The Engineer." F

SECOND-HAND DUPLEX HORIZONTAL MILLING MACHINE with hydraulic feed to table, table length 64in., width approx. 12in., electrical equipment for 400/440/3/50 cycles supply.—BOX No. E6264, "The Engineer." F

TENSILE TESTING MACHINE, in good condition, ½ ton, 1 ton, or higher, capacity ; power driven, adjustable to 1in. per minute strain rate.—BOX No. E1673, "The Engineer." F

WANTED, Machines of all Types.
CASH PAID.
Norman E. Potts (B'ham), Ltd., 130, Moseley Road, Birmingham, 12. VIC. 1278, 1279, 1270, 0856. E123 F

WANTED, Tube Expanding Machine, Tube Cleaning Machine, 6in. to 8in. Screwing Machine, with collapsible head.—Fred Watkins (Boilers), Ltd., Coleford, Glos. E997 F

FOR SALE

LOCOMOTIVES FOR SALE.—A recent large purchase enables us to offer the following range of locomotives. Copies of insurance reports available on application.—R. S. Hayes, Limited, Bridgend, Glamorgan (Telephone, Bridgend 1311/2/3) :—

Item	Bore and stroke	Type and make	When built	Working pressure, p.s.i.	Net weight, tons
1	14½×24	040 Hawthorn Leslie	—	160	22
2	14×22	040 Barclay	—	160	22
3	14×22	040 Barclay	—	160	22
4	14×22	040 Barclay	—	160	22
5	14×22	040 Barclay	—	160	22
6	14×22	040 Barclay	1935	160	22
7	17×24	040 Bagnall	1934	160	36
8	17×24	040 Bagnall	1940	160	36
9	17×24	040 Bagnall	1941	160	36
10	17×24	040 Bagnall	1941	160	36
11	17×24	040 Bagnall	1944	160	36
12	18×26	060 Bagnall	1950	180	40½

E986 G

HYDRAULIC PRESSES

Large stock of modern Presses up to 10,000 tons capacity, for Forging, Forming, Extruding, Baling and other duties.

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Replant Works, Woolwich Industrial Estate, London, S.E.18.
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VALES PLANT REGISTER, LIMITED,
OFFER FOR IMMEDIATE SALE

Large quantity of Appleby Frodingham Steel Sheet Piling for immediate disposal, comprising No. 1B in 24ft. lengths, No. 2 in 17/20ft. lengths, and No. 4 in 65/74ft. lengths. Majority new and unused.
Full details from 14, Lower Grosvenor Place, London, S.W.1. Telephone : VICtoria 7531, 3501, 8080, 9886 (15 lines). E484 G

FOR SALE

SOAG

HIGH CLASS
MILLING MACHINES
IN STOCK

VERTICAL

IL. CINCINNATI Sliding and Swivelling Head, table size 44½in. by 10½in., capacity 22in. by 14in. by 10in.
No. 2 CINCINNATI, medium speed, dial type, table size 52 11/16in. by 12½in., capacity 28in. by 12in. by 13in.
V3 MASERATI, new, high speed dial sliding and swivelling head, multi-motor drive, rapid power traverse in all directions by separate motor, table working surface 59in. by 13½in., capacity 35½in. by 11in. by 18½in., 20 spindle speeds 18-2000 r.p.m., spindle motor 10 h.p.
No. 3 CINCINNATI, high speed, dial type, table size 58½in. by 15in., capacity 34in. by 16in. by 16in.
No. 4 CINCINNATI, high speed, dial type, table size 78½in. by 16in., capacity 42in. by 16in. by 16in.
47 V HERBERT, Kneeless type, multi-motor drive, table 72in. by 17in., capacity 48in. by 16in., maximum distance table top to spindle nose 23in., 16 spindle speeds from 21 to 750 r.p.m.
CVM25 KENDALL and GENT (Kneeless), circular table type, table diameter 30in., capacity 30in. by 26in. by 32in.
28-60 CINCINNATI Vertical Hydro-Tel, fixed height bed, single power control lever, stepless feed regulation, rapid power traverse, table working surface 83in. by 28in., capacity 60in. by 30in., vertical 14in., 16 spindle speeds from 52-1300 r.p.m.

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No. 2 CINCINNATI, medium speed, dial type, table working surface 48 15/16in. by 12in., capacity 28in. by 10in. by 19in.
No. 4 CINCINNATI, medium speed, dial type, table working surface 74½in. by 16in., capacity 42in. by 14in. by 20in.
No. 2B BROWN and SHARPE Standard Plain, table working surface 51½in. by 11 11/16in., capacity 28in. by 10in. by 18½in.
VPF2 PEDERSEN, table working surface 51in. by 12in., capacity 32in. by 9in. by 18in. (new).
28in. ARCHDALE General Purpose Model, No. 14537, motor drive, table working surface 49in. by 13in., capacity 28in. by 8in. by 15½in., rapid power traverse.

UNIVERSAL

S2 CRAVEN, table size 55in. by 13in., capacity 36in. by 10in. by 16in.
2FU MASERATI, table size 55in. by 13in., capacity 36in. by 11in. by 17in.
IN PARKINSON, table size 46in. by 10½in., capacity 25in. by 9in. by 18in.

PRODUCTION

3/36 CINCINNATI Plain Hydromatic, table size 52½in. by 15in., travel 36in.
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VARIOUS

KEYWAY MILLERS AND KEYSEATERS
ASQUITH Model H.K.5 Horizontal Duplex Head Keyway and Cotterway Milling Machine for keyways up to 3½in. by 15in., table working surface 60in. by 10½in.
CARTER and WRIGHT No. 2 Dual Feed Keyseater and Vertical Miller, motor drive, max. keyway cut 1¼in. by 24in.

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We always have available late type Machine Tools of practically every description. Send us your inquiries.

SOAG MACHINE TOOLS, LTD.,
JUXON STREET, LAMBETH, LONDON, S.E.11.
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'Grams : Sotoolsag, London, S.E.11.
E211 G

600
COMPRESSOR SETS

123 c.f.m. REAVELL, 4000 p.s.i., with 95 h.p. W. H. Allen 220 volt D.C. motor.
120 c.f.m. G. and J. WEIR, 4000 p.s.i., with 95 h.p. motor, 400/440/3/50.
Two 100 c.f.m. BELLISS and MORCOM, 3600 p.s.i., with 58 h.p. L.D.C. motors, 400/3/50.
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GEORGE COHEN,
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Tel.: Pudsey 2241. E203 G

VALVES VALVES VALVES

SPECIAL OFFER—BRAND NEW VALVES by leading manufacturers, Hopkinson, Audley, Saunder, &c., in Stainless Steel, Forged Steel, Enamel and Rubber-lined Valves and Cocks. All sizes from ¼in. to 12in. bore.
PRICES : well below list.
DELIVERY : immediate ex stock.
Also large stocks of STOP VALVES, Parallel Slide, Wedge Gate, &c., REDUCING VALVES, RELIEF VALVES. Sizes up to 24in. bore.
When its VALVES—remember
G. E. SIMM (MACHINERY) LIMITED.
27, Broomgrove Road, SHEFFIELD, 10.
Telephones : 64436 (3 lines) E6203 G

FOR SALE, One Hydraulic Hot Plate Press, six openings, platen area 12ft. by 7ft. 9in., side feeding, pressure 200 lb. per sq. inch, temperature through calorifier 200 deg. Fah., suitable for plywood, rubber or laminating industries. Maker, Siemelkamp, Krefeld.

One Cold Press, 12ft. by 6ft., 3ft. daylight. Makers, Siemelkamp, Krefeld. Pressure 120 lb per sq. inch, complete with pump and all auxiliary equipment. Suitable for plywood, rubber or laminating industries. BOX No. E6254, "The Engineer." G

FOR SALE

600
STEAM TURBO-ALTERNATOR SETS

3000kW., 6600/3/50, MET.-VICK., Pass-out/Condensing Steam Turbo-Alternator Set, date 1948, designed for 340 p.s.i.g. initially, 600 deg. Fah. temperature ; also suitable for the following duties :

Output/kW.	Pass-out/lb./hour	Lb. Pressure
3000	60,000	40
1800	40,000	110
1800	40,000 double Pass/out at 1000kW., fully condensing	

2500kW., 440/3/50, B.T.H., speed 3000 r.p.m., 250 p.s.i.g., 630 deg. F., steam consumption approx. 12 8 lb./kW./hr., with surface condenser, circulating pumps, &c. Also suitable for pass-out pressures varying between 18/35 p.s.i.

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STANNINGLEY, NR. LEEDS.
Tel.: Pudsey 2241. E200 G

BRITISH ENKA, LIMITED
AINTREE, LIVERPOOL, 9

Two Brick-set Dry-back Economic Boilers, by Daniel Adamson, 10ft. dia. by 15ft. 6in. overall length ; working pressure 265 p.s.i., maximum rating 25,000 lb./hr., complete with Hodgkinsons mechanical stokers, Greens economisers, unit superheaters, Weir feed pumps, and instruments.
One Turbo-Alternator Set, with 1000kW Metro.-Vick turbine operating at 5000 r.p.m. and passing out steam at 30 p.s.i., including all ancillary equipment, and connected through reduction gearing to a 440-volt, 1640 amps., 1250kVA, open-ventilated type 3-phase alternator operating at 1000 r.p.m.
One Turbo-Alternator Set, with 2000kW Metro.-Vick. turbine operating at 6000 r.p.m., and passing out steam at 30 p.s.i., including all ancillary equipment, and connected through reduction gearing to a 440-volt, 3280 amps., 2500kVA screen-protected, type, 3-phase alternator operating at 1000 r.p.m. E6309 G

FOR SALE, one 5-ton Grafton Locomotive Steam Shunting Crane, made by Grafton and Company.
Jib size 32ft. centres.
Bevel gear travel.
Load, 5 tons at 15ft. radius, 30 cwt. at 32ft. radius.
The above crane can be seen in a partly dismantled condition.—BOX No. E6249, "The Engineer." G

FOR SALE.—40-ton capacity RAILWAY WEIGHBRIDGE by W. and T. Avery, Ltd., Type 527C. Platform 16 feet long.—Write, 1824, Wm. Porteous and Co., Glasgow. E6260 G

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GILLY
TABLE TYPE
HORIZONTAL BORERS

AFMF 65
2½in. diameter Spindle, 20in. facing cap.
*AFMF 80
3½in. diameter Spindle, 30in. facing cap.
*AFMF 100
4in. diameter Spindle, 40in. facing cap.

ALSO HEAVY TABLE TYPES WITH 5in. & 6in. SPINDLE DIAMETERS

★ Spindle speeds and table feeds in a wide range
★ Built-in swivelling table
★ Automatic facing head
★ Vernier scales and fine setting device
★ Oversize table and extended cross traverse
★ Extended vertical traverse
★ Telescopic bed covers

AMPLE POWER—HIGHEST PRECISION

Floor type borers from 5in. to 10in. spindle diameter, with automatic facing heads.

*IMMEDIATE DELIVERY
EX LONDON STOCKS

SOAG MACHINE TOOLS LTD
JUXON ST., LONDON, S.E.11
Phone : REL 7201
Grams : Sotoolsag, London, S.E.11
E210 G

Classified Advts. continued on page 128

FOR SALE

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March 12	**Miscellaneous stores**, including tools and tool kits, bicycles, welding plant, camp equipment, etc.	Central Ordnance Sub-Depot, **Westbury, Wilts.** (Sale at Corn Exchange, Devizes.)	**FARRANT, WIGHTMAN & PINNIGER** (Dept. L), 38, High Street, Swindon, Wilts. (Tel.: 5151/5152.)
March 18–19	**Miscellaneous stores**, including :—	Central Ordnance Depot, **Didcot, Berks.**	**SIMMONS & SONS** (Dept. L), 12, Station Road, Reading, Berks. (Tel.: 54025.)

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March 18–21 & 24–28	**Vehicles** and **earth moving equipment**, including :—	M.O.S. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 47271.)

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March 26	**Miscellaneous stores**	Northern Command Ordnance Sup-Depot, **Barlow, Nr. Selby, Yorkshire**	**BARTLE & SON** (Dept. L), 50–52, Merrion Street, Leeds, 2. (Tel.: 2–0898.)

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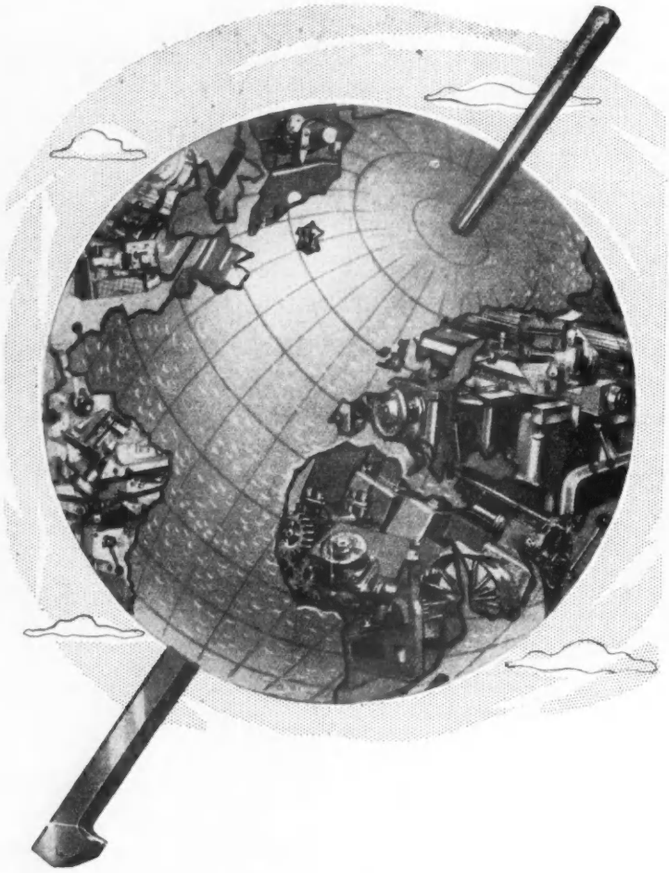

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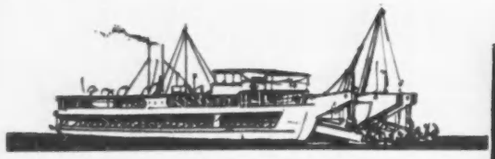

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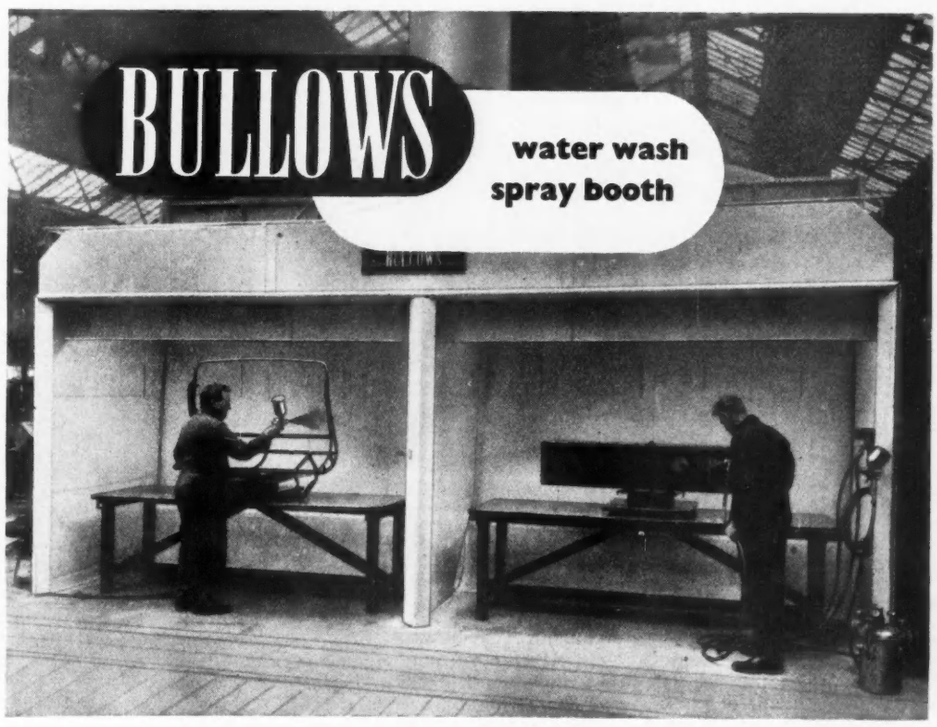

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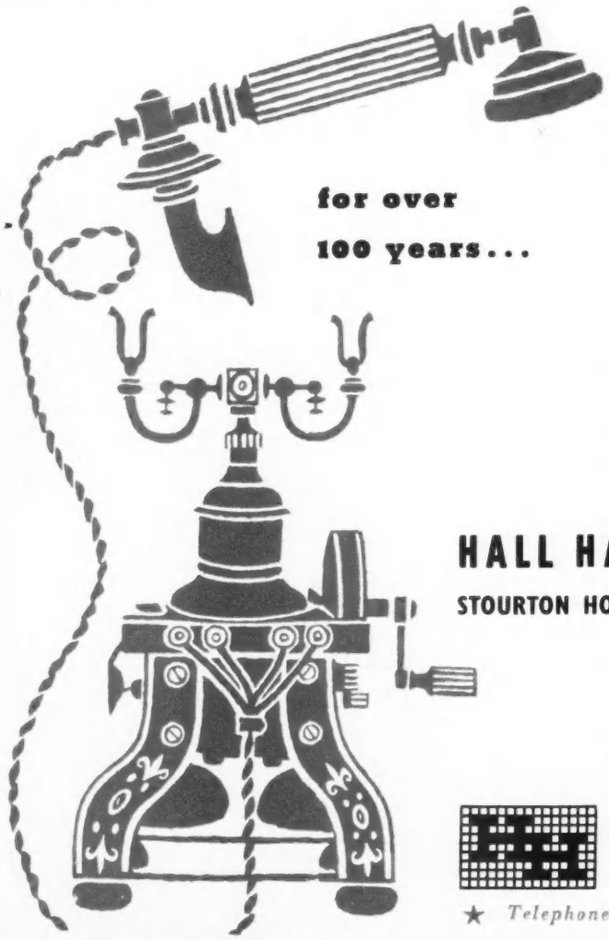

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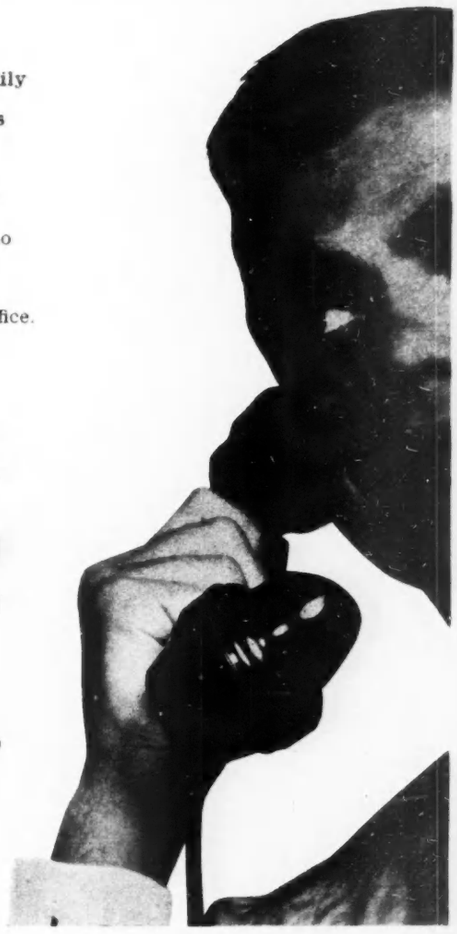

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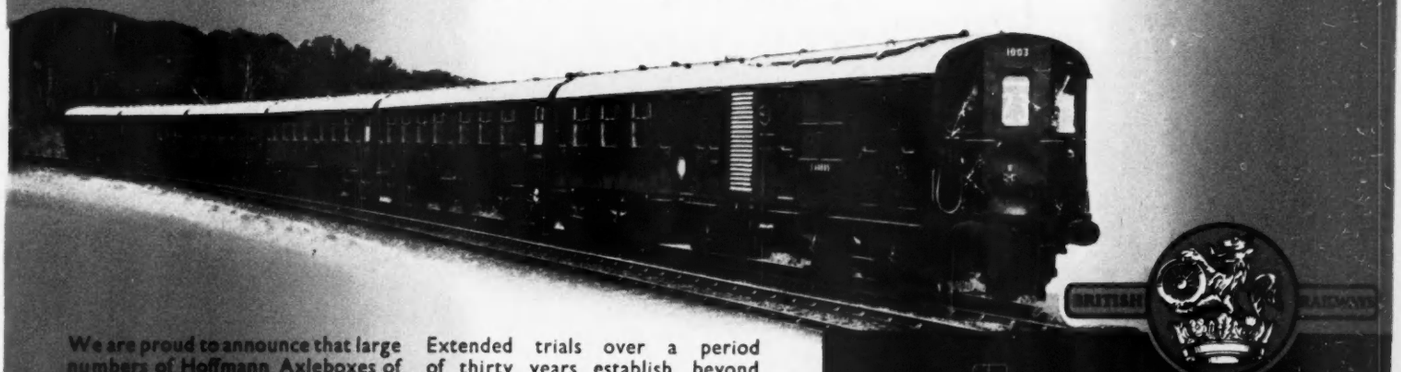

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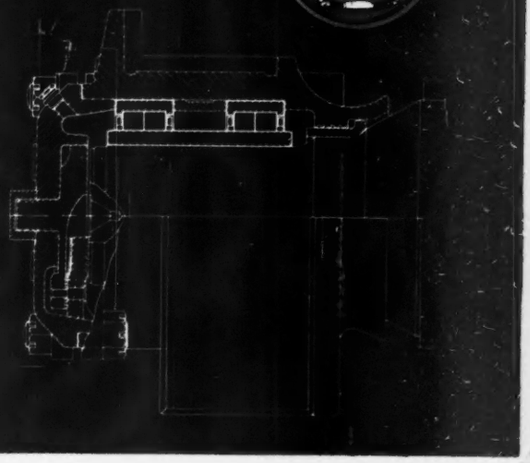

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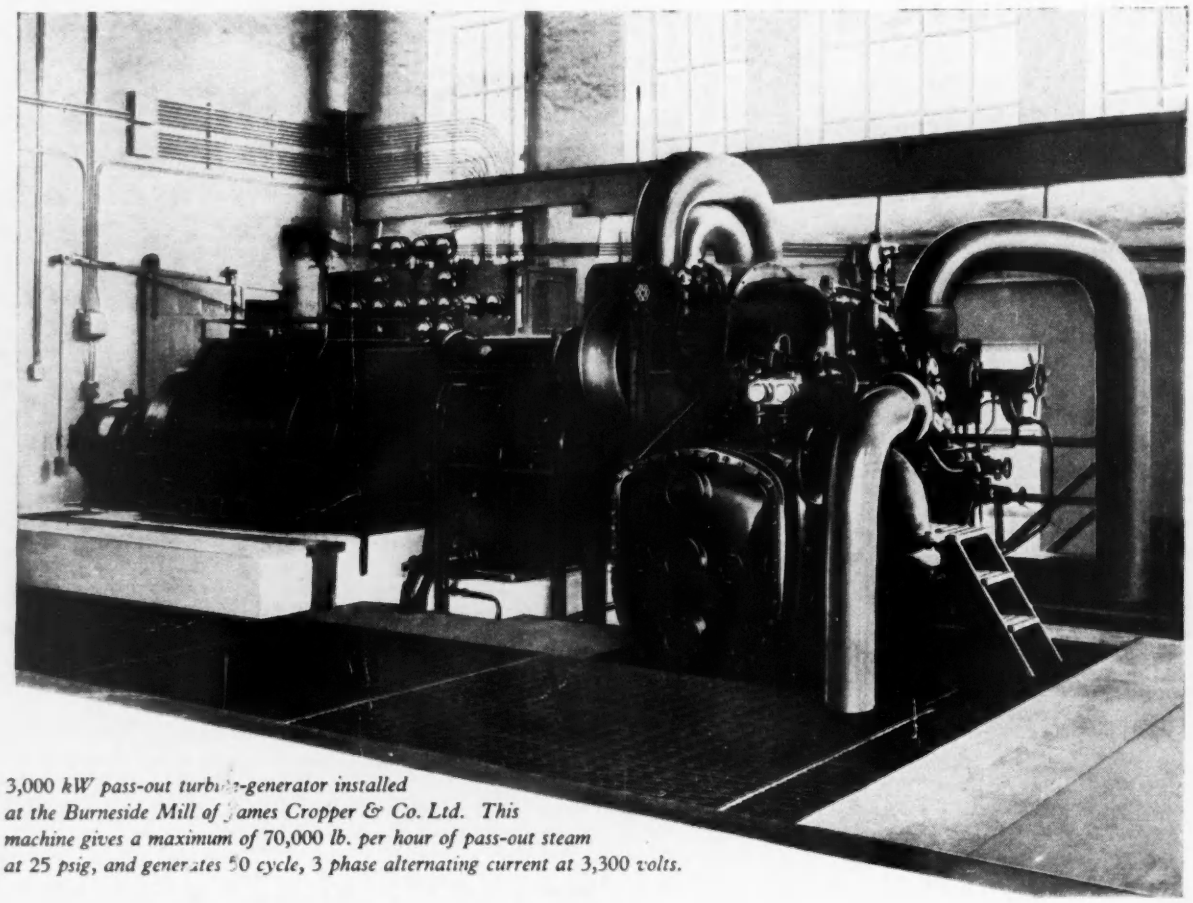

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